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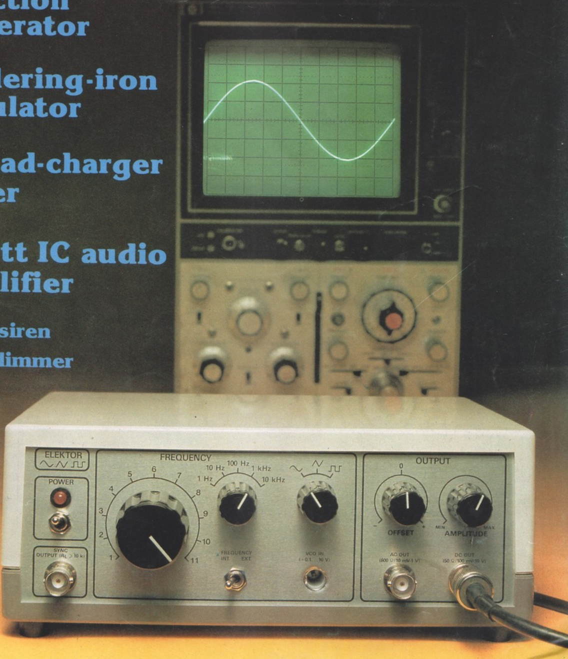

elektor contents

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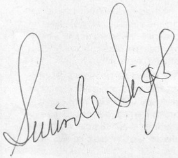

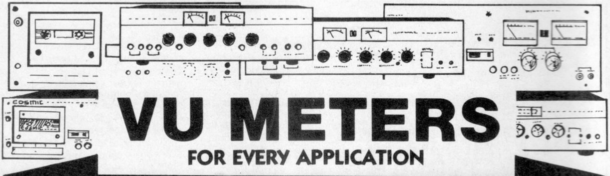

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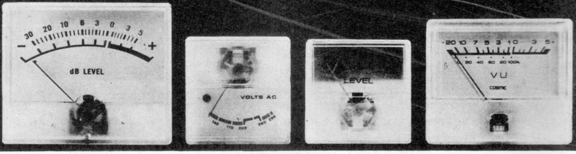

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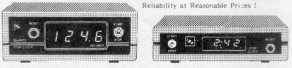

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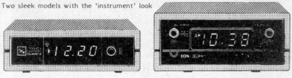

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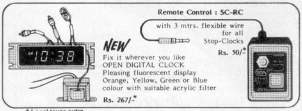

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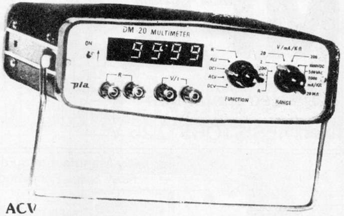

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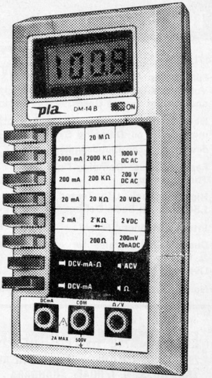

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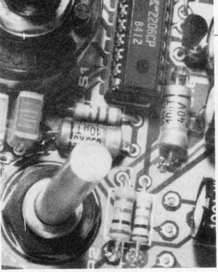


the XR2206 in the function generator

If a special IC is used in a circuit it usually means that the number of components needed is greatly reduced. There is, after all, an extremely large number of semiconductors in one 'black box', sometimes even in exactly the right configuration for a particular application. This is the case with the XR2206 used in the function generator described elsewhere in this issue. What this does not mean, however, is that the design can be made in no time at all. There is a lot more to it than simply using an application found in the manufacturer's data book.

a few remarks about the IC and the design

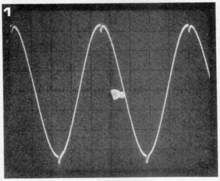


Figure 1. This photo shows an XR2206 sinewave complete with the typical spikes.

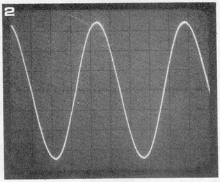


Figure 2. Again a sinewave provided by a 2206 but this one is generated by the Elektor function generator. The tops of the sine could actually be made a bit rounder. This would look better but would increase the distortion.

Function generators based on the almost legendary XR2206 usually have a few faults that are well known to users of this IC. There are dirty spikes on the peaks of the sine and triangle waves, these two waveforms become more and more similar to each other above 100 kHz and the amplitude decreases gradually then also, the frequency scale is not correct for asymmetrical waveforms (sawtooth and pulse waveforms), and the so-called sawtooth is more like an asymmetrical triangle. Apart from these points the IC works well . . .

One of the aims of the new function generator is to do away with these disadvantages. We must, however, first of all know the reason for the 'errors' before we can see how to solve them.

A better waveform

The difference between a normal XR2206-based function generator and the new Elektor design is shown by the two photographs of figures 1 and 2. These do not require any further comment. The diagrams in figures 3 and 4 show where this difference in the waveforms comes from. The standard layout is seen in figure 3, whereas figure 4 shows the basics of the new design. The heart of both is, of course, the same XR2206 whose internals are illustrated in figure 5. Where do those spikes on the sine and triangular waveforms come from? All the tests carried out suggest that the principal cause will be found in the circuitry connected to pins 13 and 14 (waveform adjust). Within the IC these two pins are connected to a differential amplifier that makes a sinewave from the triangular signal. Even a very slight capacitive load on pins 13 and 14 will cause spikes to appear in the signal, and this could be caused by even a short length of cable or by the tracks on the printed circuit board. The only solution for this is to keep all connections to pins 13 and 14 as short as possible, with extremely short copper tracks between the IC pins, the switch and the preset. This is the reason why the circuit of figure 4 uses a BS170 (V FET) for switching close to pin 14. Another cause of the spikes is the fact that the 2206 consists of a square wave and triangle generator followed by a triangle to sinewave converter. The square wave's sharp edges corrupt the other waveforms as well. If nothing is connected to the sinewave output (pin 11, which is linked to the collector of a switching transistor in the IC), or if it is short-circuited, the sinewave is completely 'clean'. As soon as a resistor is connected from pin 11 to the positive voltage supply line the spikes re-appear. A combination of square wave and (undistorted) sinewave in the same generator is only possible if the output voltage of the square wave at pin 11 is kept very small and this output is not loaded too heavily. In figure 4 pin 11 only has to drive transistor T2. The base current for the BSX20 is provided via resistor R15. If the internal transistor connected to pin 11 conducts it simply removes the base current of T2. The base-emitter junction of T2 prevents the output amplitude of pin 11 from rising above 0.6 V. The square wave at the collector of T2 still has a peak to peak value of 16 V, which is not very favourable for pin 11. The solution here is to short the output of T2 if a triangular or sinewave output is chosen. In this way the square wave is very effectively suppressed when it is not needed.

Optimal amplitude adjustment

The amplitude setting, by means of the AM input (pin 1) also appears to have quite an effect on the waveform. Cross-talk (for want of a better word) between the square wave and triangle/sine wave output (pin 2) will be reduced if a positive voltage is applied to the AM input. This is why pin 1 in figure 4 is at +4 V. At −4 V the output voltage would have been just as large but there would have been more likelihood of distortion.
The amplitude of the output voltage at pin 2 is effected by the resistance on pin 3 of the IC. To retain the same output amplitude when switching between sine and triangle the resistance at pin 3 must be about 2.7 times as high for a sine as for the triangular wave. Many 2206-based circuits simply switch the resistance at this pin but our experience shows that this is not to be recommended. Wires and tracks to the switch then make the circuit very sensitive to distortion and changing the resistance also changes the d.c. level at pin 2. This problem could be solved by duplicating P5 and P6 and then switching between these two branches. That is not what we have done, however. The amplitude and d.c. level are fixed for both waveforms with P5 and P6 and the amplitude correction needed is carried out at the output by means of voltage divider R23/R24. The impedance of this voltage divider could only be kept low by including an emitter follower (T3) before

the XR2206 in the function generator

3

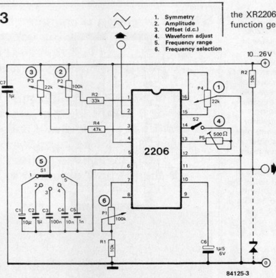


Figure 3. This is the normal layout used with the 2206. Very few external components are used but the results achieved are not very good.

4

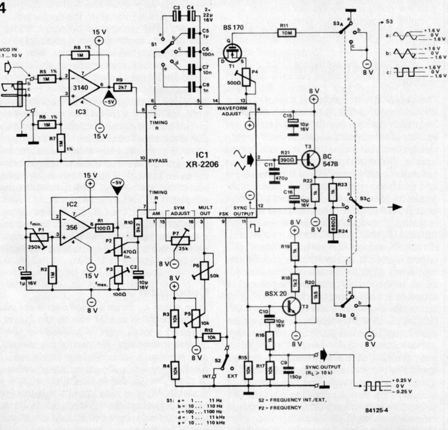
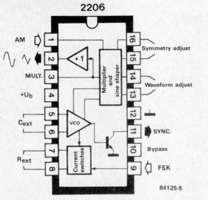


Figure 4. The Elektor function generator uses quite a few external components. Here it is seen without the output amplifier and power supply.

Figure 5. This block diagram shows the insides of the XR2206. The actual oscillator in the IC (VCO) supplies triangle and square waveforms. The frequency can be set by means of pins 7 and 8 (these are used to define the charging and discharging currents for the capacitor connected between pins 5 and 6). A sine shaper forms a sinewave from the triangle. The amplitude (pins 1 and 3) can be changed using the multiplier. Adjustment points 16/15 and 14/13 are connected to the sine shaper.

5



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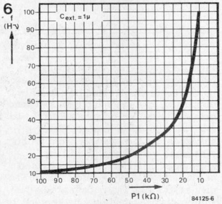


Figure 6. If the frequency is set by means of a potentiometer acting as a variable resistor the curve of frequency with respect to wiper position is far from linear. This gives a scale division that is not very user friendly.

it. A high-impedance voltage divider (such as 5k6/3k3) would, of course, do away with the need for the emitter follower but it would introduce more distortion and would make the circuit more sensitive to noise.

Frequency setting: linear and stable

The basic circuit of figure 3 uses a variable resistor (P1) to select the desired frequency. In this way the frequency is barely effected by changes in the supply voltage but the scale division is not very usable. The relationship between the resistance value (position of the wiper) and the frequency is shown in figure 6. A linear frequency scale is obtained if the voltage, rather than the resistance, at pin 7 is varied. This idea is implemented in figure 4. In this case P2 forms a voltage divider by means of which the (linear) wiper voltage is fed to R10. To prevent the frequency from being effected by variations in the supply voltage the potentiometer is connected not to the supply but to the output of a low-drift op-amp (IC2). This LF356 buffers the voltage present on pin 10 of the 2206; this pin actually provides an internal reference voltage from the IC. There are two advantages to using the reference voltage for P2: the frequency remains stable and the voltage across P2 cannot become higher than that at pin 7 (which is also connected to the reference voltage). The op-amp also 'decouples' presets P1 and P3. With this arrangement the maximum frequency can be preset using P3 without effecting the minimum frequency already set with P1. The voltage from pin 10 is also used as a reference for external frequency settings via the VCO input. In this way the optimum frequency stability is achieved.

No compromise

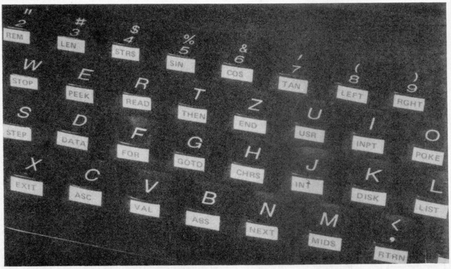
The next point on the list is the 2206's ability to generate asymmetric waveforms. To do this the time constants for the sawtooth and pulse waveform must be switched. This is achieved by tying the FSK input (pin 9) to the square wave output (pin 11) so that the capacitor between pins 5 and 6 is charged by the current from pin 7 and discharged by the current from pin 8. This is by no means a perfect solution for a number of reasons. The difference between charge and discharge times cannot be made great enough so the sawtooth looks more like an asymmetrical triangle. The frequency scale of the potentiometer on pin 7 is no longer correct as this now determines only about half of the period duration; the rest depends on the resistance or current at pin 8. The external frequency control (via the VCO input) must have an extra switch. Finally, the square wave fed through the printed circuit board and switches from pin 11 to pin 12 corrupts the other waveforms. Our answer to these points is straightforward: it is better to have no asymmetrical signals than bad ones. Regarding the stability of waveforms and amplitude above 100 kHz there is also only one acceptable solution: the frequency range should not extend beyond 100 kHz. The power supply used is completely symmetrical. This enables it to work without decoupling capacitors and the square waveform is very good even at low frequency.

All these 'improvements' on the 2206 are only possible if a double-sided printed circuit board is used. This is the only way that the critical tracks can be kept as short as possible and/or far enough from each other. This also enables the wiring between the board and switches, sockets, and potentiometers to be kept shorter and simpler. This sort of printed circuit board requires a lot of care in the design stage in order to find the best layout. In this way it is more than simply a way of interconnecting the components: it is an essential part of the circuit.

Conclusion

Even when a circuit is based on a special IC that contains almost exactly the layout required a lot of work is needed to finalise the design. No part of the project may be overlooked. We have designed the function generator carefully in order to allow the XR2206 to do its job as well as possible. What is also important is that we have not pushed the IC to its limits. Doing this could only have meant that the circuit would be full of compromises. ■

One of the less pleasant aspects of programming is having to spend hours just typing in a BASIC program. You arrive at line 8760 and have to type: P-O-K-E-P-T-,-A-S-C-(-M-I-D-$-(-X-$-,-S-,-1-)-) . . . or something similar and wonder how secretaties can type the whole day long.
Fortunately there is a cure for this ailment. Shortened forms of the BASIC instructions can be used: for example O for POKE, C for ASC, M for MID$ and so on. All that is needed to enable this shorthand to be used is a small machine code program intended for 6502-based systems, and the Junior Computer in particular. Then you can concentrate on your program instead of having to worry about the typing.



short-hand BASIC

short-hand BASIC
short-hand BASIC

allows BASIC programs to be typed two or three times as fast as normal

The purpose of the machine code program given here is to provide an abbreviation for a number of BASIC instructions (particularly the long ones, like RIGHT$) so that they do not have to be typed out longhand every time. A single letter will be enough to identify an instruction if it is preceded by the ASCII code 1BHEX, in other words if the Escape key is first pressed. This indicates to the computer that the next character is not an ordinary one and should be treated as the abbreviation for an instruction. An R following an Escape would then give READ, and P would give PRINT. The first function of our routine is to filter the Escape code. The following character must be one of those that corresponds to an abbreviation. When this has been confirmed the program then outputs the complete instruction as if it had been typed in letter by letter via the keyboard.

Two look-up tables

The whole routine is relatively simple but it does make use of some rather clever vector manipulations. The flowchart shown in figure 1 should make it easier to understand. Clearly this 'program' is really only a subroutine and the user exits from it by means of an RTS command. The clever part consists of changing the return address to our routine just before leaving it using the RTS instruction. But let's start at the beginning.
When BASIC is waiting for something from the user, or, to be exact, from the keyboard, it enters a wait loop that it only leaves when it receives the ASCII code for CR (carriage return). This character receiving loop is where we enter the scene. In order to do this we must change one vector: the address of the reception routine (RECCHA, for example) is replaced by the address of the routine to which we want to send the processor, which in this case is the address of label SHHAND at EØØØHEX. In the Junior Computer and similar systems this change is done at the level of the DOS input/output distributor. This distributor is made up of two bytes, one for inputs (2321HEX) and the other for outputs (2322HEX). Each bit in these two bytes corresponds to a specific input or output routine (keyboard, RS232 output, Centronics output, memory, etc.), whose addresses are found in a look-up table (23Ø1. . .231F). In this table we replace the address for the routine to receive a character from the keyboard with the address of the routine described in this article.
We are then at the cold start entry of figure 1. A character is first read from the keyboard and analysed. If it is not the code for the Escape key the routine stops

immediately and the character is treated normally. If, on the other hand, the character in question is the Escape code the cursor starts flashing to indicate that the special abbreviation routine is in operation. The next character can either be the Escape code again, in which case the routine is stopped, or one of the abbreviations listed in the look-up table reproduced in the listing. The 6502's Y register serves as an index while this table is being referenced. Whenever the character received after the Escape corresponds to one of those in the table the processor can locate the complete instruction based on the contents of index register Y. All it has to do is seek it in another look-up table located in the BASIC interpreter starting at address Ø284HEX. As we can see from table 1, all the instructions known to the interpreter are found there. In order to distinguish them from one another the ASCII code for the last character in each instruction has been changed. Its bit seven, which is normally '0', is set to '1' and then serves to indicate the end of an instruction. An example of this is seen at Ø286HEX; this address should contain 44HEX (the 'D' in END) but it actually contains C4HEX.

1

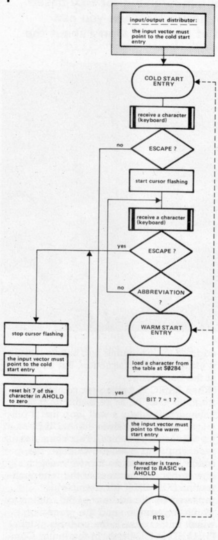


Figure 1. This flowchart shows how the abbreviation routine itself determines from which entry it is started. Its decision is based on whether the previous character received is the last in a chain corresponding to the abbreviated instruction.

ABS	B
AND	A
ASC	C
CHR$	H
COS	6
DATA	D
DEF	@
DIM	1
DISK	K
END	Z
EXIT	X
EXP	↑
FOR	F
GOSUB	.
GOTO	G
INPUT	I
INT	J
LEFT$	8
LEN	3
LIST	L
LOG	Ø
MID$	M
NEW	FF (ØCHEX)
NEXT	N
NOT	_
PEEK	E
POKE	O
POS	LF (ØAHEX)
PRINT	P
READ	R
REM	2
RESTORE	BS (Ø8HEX)
RETURN	,
RIGHT$	9
RND	/
RUN	CR (ØDHEX)
SGN	;
SIN	5
SPC(	SP (2ØHEX)
SQR	Q
STEP	S
STOP	W
STR$	4
TAB(	MT (Ø9HEX)
TAN	7
THEN	T
TRAP	Y
USR	U
VAL	V

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02A0: D4 47 4F 54 CF 52 55 CE 49 C6 52 45 53 54 4F 52 .GOT.RU.I.RESTOR
02B0: C5 47 4F 53 55 C2 52 45 54 55 52 CE 52 45 CD 53 .GOSU.RETUR.RE.S
02C0: 54 4F D0 4F CE 45 44 49 D4 54 52 41 D0 45 58 49 TO.O.EDI.TRA.EXI
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02E0: D4 43 4F 4E D4 4C 49 53 D4 43 4C 45 41 D2 4E 45 .CON.LIS.CLEA.NE
02F0: D7 54 41 42 A8 54 CF 46 CE 53 50 43 A8 54 48 45 .TAB.T.F.SPC.THE
0300: CE 4E 4F D4 53 54 45 D0 AB AD AA AF DE 41 4E C4 .NO.STE......AN.
0310: 4F D2 BE BD BC 53 47 CE 49 4E D4 41 42 D3 55 53 O....SG.IN.AB.US
0320: D2 46 52 C5 50 4F D3 53 51 D2 52 4E C4 4C 4F C7 .FR.PO.SQ.RN.LO.
0330: 45 58 D0 43 4F D3 53 49 CE 54 41 CE 10 10 90 50 EX.CO.SI.TA....P
0340: 45 45 CB 4C 45 CE 53 54 52 A4 56 41 CC 41 53 C3 EE.LE.STR.VA.AS.
0350: 43 48 52 A4 4C 45 46 54 A4 52 49 47 48 54 A4 4D CHR.LEFT.RIGHT.M
0360: 49 44 A4 00 4E C6 53 CE 52 C7 4F C4 46 C3 4F D6 ID..N.S.R.O.F.O.
0370: 4F CD 55 D3 42 D3 44 C4 2F B0 49 C4 54 CD 4C D3 O.U.B.D./.I.T.L.
```

Table 1. The BASIC interpreter has itself a look-up table where it can find the reserved words corresponding to instructions. This table allows us to reconstitute the complete instructions from abbreviations.

Changing the vectors

Now we have arrived at the most interesting part of the program: the cold start entry. The processor then loads a character from the look-up table indexed by register Y and examines its bit 7. If it is logic low it is not the last character in the chain so there are more that must be loaded to complete the instruction. This explains the changing of the vector for the input distributor so that in order to receive the next character the processor returns to the warm (rather than cold) entry to our routine. As soon as the character received has been converted to BASIC (the character is stored in buffer AHOLD while the RTS instruction is carried out) we return to the abbreviation handling routine, this time by the warm start entry. A new character is then loaded from the look-up table. If its bit 7 is logic high this means that the instruction is now complete. The cursor flashing can now be stopped and then the input distributor vector is again changed so that it once again points at the cold start entry to our routine.

Before the last character (stored in AHOLD while the RTS instruction is being executed) is transferred to BASIC its bit 7 must be reset to zero. The whole abbreviation routine is carried out in a fraction of a second. The user presses the Escape key and then R, for example, and the word READ appears immediately on the screen.

The complete listing of this machine code routine is given in table 2. The outlines that are shown in the flowchart of figure 1 are easily picked out. There are still some things that should be said, however. As we have dealt with the working of this routine in some detail it should be quite easy to change it to suit any system other than the Junior Computer. The flashing cursor is just an 'accessory'; it could be replaced by another signal if you prefer. Note the absolute addresses: the input distributor (IOTABL), the buffer for the character that is being transferred (AHOLD), the

```
0010: E000                ORG   $E000
0020:
0030:                SHORTHAND BASIC COMMANDS FOR JUNIOR COMPUTER
0040:
0050:                ORIGINAL FOR SUPERBOARD II AND
0060:                CHALLENGER C1P
0070:                FROM: "MICRO. MAY 1980". HENK J. WEVERS
0080:
0090:                PETER THEUNISSEN
0100:
0110:                OS65D INPUT DISPATCH TABLE
0120:
0130: E000           IOTABL *     $2301
0140:
0150:                CRT ADDRESSES
0160:
0170: E000           AR     *     $D800  CRT ADDRESS REGISTER
0180: E000           RFILE  *     AR     +01 REGISTER FILE
0190:
0200:                TEMPS
0210:
0220: E000           AHOLD  *     $2363  ACCUMULATOR HOLD
0230: E000           TEMPY  *     $E0BC  TEMPORARY Y-BUFFER
0240:
0250:                EXTERNAL ROUTINES
0260:
0270: E000           RECCHA *     $FE1B  RECEIVE CHARACTER FROM KEYBOARD
0280:
0290:                LOOK-UP TABLES
0300:
0310: E000           BASCOM *     $0284  BASIC COMMAND LOOKUP TABLE
0320:
0330:
0340:                *** MAINPROGRAM ***
0350:
0360:
0370: E000 20 1B FE  SHHAND JSR   RECCHA GET CHARACTER FROM KEYBOARD
0380: E003 C9 1B            CMPIM $1B    IS IT ESCAPE?
0390: E005 F0 01            BEQ   FLCUR  IF YES. BRANCH
0400: E007 60               RTS          IF NO. RETURN TO BASIC
0410: E008 A9 0A     FLCUR  LDAIM $0A
0420: E00A 8D 00 D8         STA   AR     SELECT CURSOR CONTROL REGISTER
0430: E00D AD 01 D8         LDA   RFILE
0440: E010 09 60            ORAIM $60    SET B5.B6 FOR FLASHING CURSOR
0450: E012 8D 01 D8         STA   RFILE
0460: E015 A2 43     MAXTBL LDXIM $43    LOAD MAX. TABLE INDEX
0470: E017 20 1B FE         JSR   RECCHA GET SHORTHAND COMMAND FROM KEYBOARD
0480: E01A C9 61     NONCAP CMPIM $61
0490: E01C 90 06            BCC   SEARCH BRANCH IF CHARACTER < a
0500: E01E C9 7B            CMPIM $7B
0510: E020 B0 02            BCS   SEARCH BRANCH IF CHARACTER > z
0520: E022 29 DF            ANDIM $DF    TURN CHAR. IN ACCU INTO CAPITAL
0530: E024 C9 1B     SEARCH CMPIM $1B    IS IT ESCAPE?
0540: E026 F0 35            BEQ   LASTCH IF YES. RETURN TO BASIC
0550: E028 DD 78 E0         CMPX  TABLE  COMPARE WITH TABLE
0560: E02B F0 05            BEQ   FOUND  FOUND IT? THEN BRANCH
0570: E02D CA               DEX          NEXT TRY
0580: E02E 10 F4            BPL   SEARCH IF NOT FOUND. LOOP BACK
0590: E030 30 E3            BMI   MAXTBL NO MATCH? IGNORE AND GET NEW COMMAND
0600: E032 E8        FOUND  INX          PREPARE X AND
0610: E033 A0 FF            LDYIM $FF    Y FOR LOOKUP IN BASIC COMMAND TABLE
0620: E035 CA        BACMND DEX          NEXT BASIC COMMAND
0630: E036 F0 08            BEQ   SAVEY  ARRIVED AT CORRECT COMMAND? BRANCH
0640: E038 C8        SKIP   INY          NOT YET ARRIVED? SKIP CURRENT COMMAND
0650: E039 B9 84 02         LDAY  BASCOM DONE YET?
0660: E03C 10 FA            BPL   SKIP   NO? LOOP BACK
0670: E03E 30 F5            BMI   BACMND YES? TRY NEXT ONE
0680: E040 8C BC E0  SAVEY  STY   TEMPY  SAVE Y-REGISTER
0690: E043 AC BC E0  GETCMD LDY   TEMPY  RECALL Y-REGISTER
0700: E046 C8               INY          INCREMENT CHAR.POINTER
0710: E047 B9 84 02         LDAY  BASCOM GET ONE CHARACTER FROM COMMAND
0720: E04A 8D 63 23         STA   AHOLD  HOLD CHARACTER FOR BASIC INPUT
0730: E04D 30 0E            BMI   LASTCH LAST CHAR. FOUND? THEN BRANCH
0740: E04F 8C BC E0         STY   TEMPY  SAVE Y-REGISTER
0750: E052 A2 42            LDXIM $42    GETCMD ADDRESS -01 TO X
0760: E054 A0 E0            LDYIM $E0    AND Y-REGISTER
0770: E056 8E 01 23  STORE  STX   IOTABL ADDRESS IN X- AND Y-REGISTER TO
0780: E059 8C 02 23         STY   IOTABL +01 BASIC INPUT VECTOR TABLE
0790: E05C 60               RTS          RETURN TO BASIC
0800: E05D A9 0A     LASTCH LDAIM $0A
0810: E05F 8D 00 D8         STA   AR     SELECT CURSOR CONTROL REGISTER
0820: E062 AD 01 D8         LDA   RFILE
0830: E065 29 9F            ANDIM $9F    SET FOR NON-FLASHING CURSOR
0840: E067 8D 01 D8         STA   RFILE
0850: E06A A9 7F            LDAIM $7F
0860: E06C 2D 63 23         AND   AHOLD  STRIP B7
0870: E06F 8D 63 23         STA   AHOLD
0880: E072 A2 FF            LDXIM $FF    SHHAND ADDRESS -01 TO X
0890: E074 A0 DF            LDYIM $DF    AND Y-REGISTER
0900: E076 D0 DE            BNE   STORE  BRANCH ALWAYS
0910:
0920:
0930:
0940:                SHORTHAND COMMAND TABLE
0950:
0960: E078 5A        TABLE  =     'Z     END
0970: E079 46               =     'F     FOR
0980: E07A 4E               =     'N     NEXT
0990: E07B 44               =     'D     DATA
1000: E07C 49               =     'I     INPUT
1010: E07D 31               =     '1     DIM
1020: E07E 52               =     'R     READ
1030: E07F FF               =     $FF
1040: E080 47               =     'G     GOTO
1050: E081 0D               =     $0D    RUN
1060: E082 FF               =     $FF
1070: E083 08               =     $08    RESTORE
1080: E084 2E               =     '.     GOSUB
1090: E085 2C               =     ',     RETURN
1100: E086 32               =     '2     REM
1110: E087 57               =     'W     STOP
1120: E088 FF               =     $FF
1130: E089 FF               =     $FF
1140: E08A 59               =     'Y     TRAP
1150: E08B 58               =     'X     EXIT
1160: E08C 4B               =     'K     DISK
1170: E08D 40               =     $40    DEF
1180: E08E 4F               =     'O     POKE
1190: E08F 50               =     'P     PRINT
1200: E090 FF               =     $FF
1210: E091 4C               =     'L     LIST
1220: E092 FF               =     $FF
1230: E093 0C               =     $0C    NEW
1240: E094 09               =     $09    TAB(
1250: E095 FF               =     $FF
1260: E096 FF               =     $FF
1270: E097 20               =     $20    SPC(
1280: E098 54               =     'T     THEN
1290: E099 2D               =     '-     NOT
1300: E09A 53               =     'S     STEP
1310: E09B FF               =     $FF
1320: E09C FF               =     $FF
1330: E09D FF               =     $FF
1340: E09E FF               =     $FF
1350: E09F FF               =     $FF
1360: E0A0 41               =     'A     AND
1370: E0A1 FF               =     $FF
1380: E0A2 FF               =     $FF
1390: E0A3 FF               =     $FF
1400: E0A4 FF               =     $FF
1410: E0A5 3B               =     ';     SGN
1420: E0A6 4A               =     'J     INT
1430: E0A7 42               =     'B     ABS
1440: E0A8 55               =     'U     USR
1450: E0A9 FF               =     $FF
1460: E0AA 0A               =     $0A    POS
1470: E0AB 51               =     'Q     SQR
1480: E0AC 2F               =     '/     RND
1490: E0AD 30               =     '0     LOG
1500: E0AE 5E               =     '^     EXP
1510: E0AF 36               =     '6     COS
1520: E0B0 35               =     '5     SIN
1530: E0B1 37               =     '7     TAN
1540: E0B2 FF               =     $FF
1550: E0B3 45               =     'E     PEEK
1560: E0B4 33               =     '3     LEN
1570: E0B5 34               =     '4     STR$
1580: E0B6 56               =     'V     VAL
1590: E0B7 43               =     'C     ASC
1600: E0B8 48               =     'H     CHR$
1610: E0B9 38               =     '8     LEFT$
1620: E0BA 39               =     '9     RIGHT$
1630: E0BB 4D               =     'M     MID$
1640:
```

Table 2. This is the complete listing of the shorthand BASIC routine. Naturally the shorthand command table in the listing can be changed. It is essential, however, to retain the order of instructions given here (i.e. END — FOR — NEXT etc.) but different abbreviations may be used. Note that the list of abbreviations and instructions given in the margin of the page opposite is sorted into alphabetical rather than logical order.

keyboard reception routine (RECCHA) and the look-up table for the interpreter (BASCOM). These are not directly compatible with systems other than the Junior. There are also some absolute addresses at lines 750, 760, 880 and 890 of the listing. If the routine is placed at a different location to the one we have used these addresses must also be changed. Two things have to be done in order to incorporate this routine in your system. First it must be loaded to memory (from a diskette). Next the input vector at 2301 HEX must be changed so that it points to the start of our routine. If this starts at E000, as it does here, the vector will be DFFF HEX (= E000 — 1). In BASIC this gives POKE 8961,255: POKE 8962,223. ◄

function generator

A function generator is without doubt an essential part of any serious electronics hobbyist's laboratory. It is indispensible wherever sinewaves, triangle waves or square waves are needed. In the January 1978 issue of Elektor (UK) we published a design for a function generator and since then it has remained a very popular project. The new design we present here uses the same function generator IC as its predecessor: the XR2206 from Exar. We have, of course, taken note of the advances that the last seven years have brought so this new function generator is a great improvement over the old, being more sophisticated and more capable in many areas.

made-to-measure waveforms

Technical specifications

- **Frequency range:** 1 Hz...110 kHz, divided into five decades
- **External-voltage controlled:** 0.1...10 V on the VCO input gives a frequency range of 1...100, input impedance is 1 MΩ
- **Waveforms:** sine, triangle, square
- **Harmonic distortion on the sinewave:** 0.5%
- **DC OUT:** all waveforms, amplitude 100 mV...10 V_{pp}, d.c. level adjustable from −5 V to +5 V, output impedance is 50 Ω, short-circuit protected
- **AC OUT:** all waveforms, amplitude 10 mV...1 V_{pp}, frequency range 0.1 Hz...110 kHz (−3 dB), output impedance is 600 Ω, short circuit protected
- **SYNC OUTPUT:** square wave, amplitude 500 mV_{pp}, no d.c. voltage component present, output impedance is 1 kΩ, short circuit protected, shut-off impedance > 10 kΩ

Although the 'simple function generator' described in January 1978 (UK issue) was (and is) a popular project, the time has come for it to be replaced. Over the years many things change and technology, in particular, has taken big steps forward. A new function generator would therefore seem to be in order. Furthermore, it will not have escaped our readers' attention that Elektor has been publishing a series of test instruments. Actually, it is not really a series, but as we had quite a few lab instruments on our planning sheets we felt it would be worth while to put them all in the same cases to form a 'family'. It all started with the pulse generator and capacitance meter, now we add a function generator and next month it will be a frequency counter. What comes after that you will just have to wait and see.

A new function generator could be expected to have a completely new concept and be made with the latest ICs. That is what we thought as well but after searching for a replacement for the XR2206 we decided to remain faithful to this old IC. There are a number of reasons for this. First of all, the function generator must retain a fairly simple layout. The circuit must not become too expensive and it must not contain exotic ICs that are not freely available. A completely discrete circuit seemed too complicated to guarantee that every one built would work properly. A digital solution (with the waveform stored in an EPROM followed by a digital to analog converter) would be very up to date but would require expensive, difficult to find components. What it all comes down to is this: although ten years old, the XR2206 still seems the best IC to use as the heart of a new function generator.

Deciding to use the XR2206 in a new function generator does not mean falling back on an old design. We have used a number of clever (we are modest today, aren't we) solutions to overcome the well-known (infamous even) drawbacks of the 2206. How this is done is described elsewhere in this issue by the article 'the XR2206 in the function generator'.

What can it do?

The aim was clear: to develop a small, efficient function generator. Nobody wants a huge case covered in knobs and switches if they can have a good-quality basic instrument that is not completely shadowed by the (rather expensive) ready-made units that are available. As the technical specifications in the table here show, we think we have succeeded in this and even the front panel (figure 5) is quite attractive. The standard waveforms are available: sine, triangle and square. Price considerations mean that digital frequency setting and read-out have not been included. This is taken care of by a single knob, which, once calibrated, is accurate enough. It is always possible to connect a frequency meter to the generator to see exactly what frequency is selected. For normal use it is important to have a large output-voltage range with a variable offset level. The DC OUTput has a maximum amplitude of 10 $V_{peak-peak}$ at an output impedance of 50 Ω. The offset can be varied between −5 V and +5 V, which is of particular use where a square wave at TTL or CMOS level is needed. A separate output for audio use (AC OUT) is fitted with an output capacitor; its signal level can be set between 10 mV and 1 V (again peak-peak) and the output impedance is 600 Ω.
The signal is kept as clean as possible at higher frequencies by the use of a wide-band d.c.-coupled output amplifier. To be honest we must admit that the sine waveform is not completely free of distortion but this is an evil shared by almost all function generators. Distortion measurements on hi-fi equipment should be made with an actual sinewave generator (such as a Wien bridge oscillator). We have none the less done our best to make the sinewave as pure as possible. The result of our labour is shown in figure 1; the upper trace shows the waveform from the Elektor function generator while underneath this is the equivalent from a ready-made generator that is also based on the 2206. Clearly, 'our's' is the better waveform, with less than 0.5% harmonic distortion.
Another important detail is the VCO input. This is used to provide a linear frequency control in a range of 1...100|based on a d.c. voltage of 0.1...10 V
The circuit will only work optimally if the tracks on the printed circuit board and the wiring in general are kept short. For this reason the board we have designed is double-sided. This not only improves the quality of the waveform, it also makes construction easier.

The circuit

We will start with the simplest part of the circuit: the power supply. This has the usual configuration with centre-tapped mains transformer, bridge rectifier and a pair of voltage regulators (IC4 and IC5) to provide the symmetrical + and −15 V. The purpose of LED D9 is to indicate that the generator is switched on. The maximum supply voltage to the XR2206 is only 26 V, however, so + and −8 V are fed to pins 4 and 12 of IC1 respectively via zener diodes D7 and D8. Within the IC is a very stable voltage reference giving 3 V d.c. (relative to the negative supply line). This voltage, which is available at pin 10 of the IC, is decoupled by capacitor C1 and is used in this circuit as a reference for the frequency setting by means of P2. The reference is buffered by IC2 in order to reduce the load on it. This same reference voltage is also present at pin 7 of IC1. The frequency of the 2206 is directly proportional to the current flowing from this pin, which is determined by the voltage at the wiper of potentiometer P2. When the voltage here is high, 3 V for example, very little current flows so the frequency is at its minimum (f_{min}). The frequency is highest (f_{max}) if the voltage at the wiper is low (when the wiper is turned completely to the negative supply side). Note that all the voltages quoted here are relative to the negative supply line. The lower and upper limits of the frequency scale can be changed with presets P1 and P3.
The FSK input, pin 9, of the IC is used to switch the frequency setting of the 2206 from pin 7 to pin 8. When S2 is switched to EXT potentiometer P2 no longer has any effect and it is the current from pin 8 that determines the frequency. This current depends on the control voltage across resistor R9, which is provided by the VCO input via IC3. The 3140 inverts the VCO voltage so that when it increases the frequency also increases. At the same time IC3 serves to ensure that the VCO voltage range corresponds to the range to which IC1 reacts. To do this the non-inverting input of IC3 is linked to the 3 V reference via voltage divider R6/R7. If the VCO input is not required this whole section can be omitted. This includes IC3, R5...R9 and S2. The connection for the common pole of S2 must then be

1

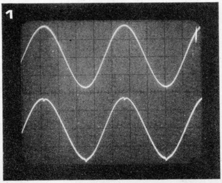


Figure 1. The sinewaves generated by the Elektor function generator (above) and a ready-made equivalent (below).

2

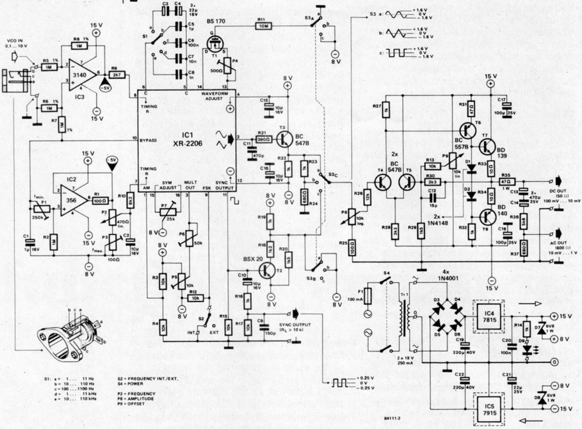


Figure 2. The circuit of the function generator consists of three basic sections: the generator based on IC1, the d.c.-coupled output amplifier (T4...T8) and the symmetrical supply (IC4 and IC5).

grounded. The actual frequency range of the generator is decided by capacitors C3...C8 and is switched by means of switch S1. Two electrolytics in series are used for the lowest range, giving the equivalent of a bipolar 11 μF capacitor.

A rather complex procedure is used for selecting the different waveforms, based on three-pole switch S3. A sinewave is produced when S3 is in position a. Part A of the switch then electronically inserts preset P4 between pins 13 and 14 (waveform adjust) via VMOSFET T1. Part B shorts the output of T2 by connecting it to −8 V so that the square wave cannot distort the sinewave. Part C feeds the signal from IC1, after buffering by T3, to the output amplifier.

Position b selects the triangular waveform. Section A now deselects the forming of a sinewave via the BS170, section B still disables the square wave and section C again feeds the signal to the output amplifier. One small change noted in this position is that the signal from IC1 (pin 2) travels via a voltage divider after T3. This is needed to keep the amplitudes of the sine and triangle the same at the output as the XR2206 gives the triangle a much greater amplitude than the sine.

The square wave is selected when S3 is in position c. Again T1 is kept 'off' by means of part A. Section B allows the square wave, which is amplified by T2, to pass on via section C to the output amplifier.

The square wave is always available at the SYNC OUTPUT of IC1 (pin 11). Its amplitude is only 0.5 V_{pp} but it is a pure waveform. All d.c. components are blocked by capacitor C10. The symmetry of the waveform can be changed by means of preset P7 connected between pins 15 and 16. The amplitude of the signal output at pin 2 is set with preset P6 and its d.c. value is changed by means of preset P5. The AM input of the 2206 (pin 1) is fixed at +4 V d.c. by voltage divider R3/R4.

The output amplifier is completely discrete, consisting of a differential amplifier (T4 and T5), a driver (T6) and two power transistors (T7 and T8). The gain of this whole section is determined by the ratio R30 : R29, which works out at a little more than three times. A 15 pF capacitor, C12, is included to ensure frequency stability without effecting the amplifier's slew rate too much. The quiescent current of the output stage is set by diodes D1 and D2. The output current is limited by resistor R35, which also defines the impedance of the DC OUTput. The d.c. offset can be set with potentiometer P9. Output 'volume' is controlled by means of P8. A bipolar electrolytic, consisting of capacitors C13 and C14, is used for d.c. suppression. The output voltage is lowered by voltage divider R36/R37, whose values are chosen to give an impedance of 600 Ω.

3

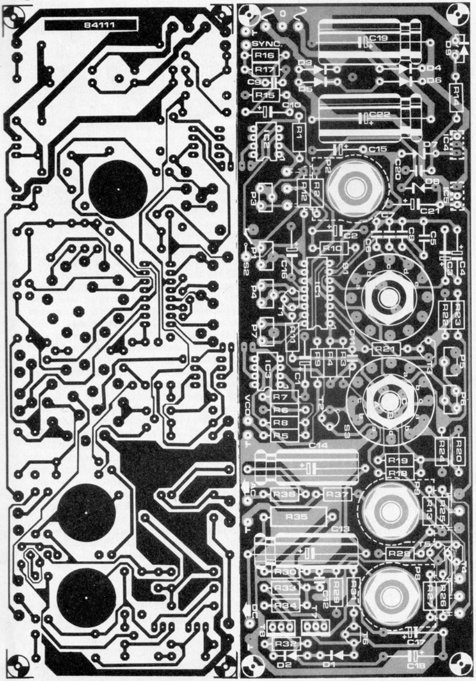


Figure 3. The printed circuit board for the function generator is double-sided, thus keeping wiring to a minimum and the connections to the board short.
Both sides of this board are shown on the printed circuit board pages near the centre of this issue.

Parts list

Resistors:
R1, R25 = 100 Ω
R2 = 1 M
R3, R4, R12, R13, R15, R17 = 10 k
R5, R6, R7, R8 = 1 M, 1% metal film
R9 = 2k7
R10 = 8k2
R11 = 10 M
R14, R16, R19, R22, R23, R27, R32 = 1 k
R18 = 1k2
R20, R29 = 1k5
R21 = 390 Ω
R24, R37 = 680 Ω
R26 = 12 k
R28, R30 = 3k3
R31 = 47 Ω
R33, R34 = 10 Ω
R35 = 47 Ω/1 W
R36 = 5k6
P1 = 250 k preset (vertical type)
P2 = 470 Ω wire-wound pot (with long spindle)
P3 = 100 Ω preset (vertical type)
P4 = 500 Ω preset (vertical type)
P5 = 10 k preset (vertical type)
P6 = 50 k preset (vertical type)
P7 = 25 k preset (vertical type)
P8 = 10 k log. pot. (long spindle)
P9 = 10 k lin. pot. (long spindle)

Capacitors:
C1 = 1 μ/16 V
C2, C10, C15, C16 = 10 μ/16 V
C3, C4, C21 = 22 μ/25 V
C5 = 1μ (MKT)
C6 = 100 n (MKT)
C7 = 10 n (MKT)
C8 = 1 n (MKT)
C9 = 150 p
C11 = 470 p
C12 = 15 p
C13, C14 = 470 μ/25 V
C17, C18 = 100 μ/25 V
C19, C22 = 220 μ/40 V
C20 = 100 n

Semiconductors:
D1, D2 = 1N4148
D3...D6 = 1N4001
D7, D8 = 6V8/1 W zener
D9 = LED, red
T1 = BS170
T2 = BSX20, 2N2369
T3...T5 = BC547B
T6 = BC557B
T7 = BD139
T8 = BD140
IC1 = XR2206
IC2 = LF356N
IC3 = CA3140E
IC4 = 7815
IC5 = 7915

Switches:
S1 = double-pole 6-way rotary wafer switch
S2 = miniature single-pole toggle switch
S3 = 4-pole 3-way rotary wafer switch
S4 = miniature double-pole mains switch

Miscellaneous:
F1 = fuse, 100 mA
Tr1 = mains transformer, 2 × 18 V/250 mA
3 off BNC sockets (screw mounting)
1 off d.c. power socket for VCO input (see figure 2) (*Cirkit/Ambit*)
Heatsink for IC4 and IC5

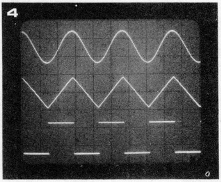


Figure 4. These are the output signals that the function generator can provide: a sine, triangle and square wave (200 μs/division horizontal, 1 V/division vertical).

Take care in construction

Any test equipment, especially if it is home-made, must be trustworthy. This is only possible if it is constructed and calibrated very carefully so read the rest of this article before plugging in your soldering iron.

The printed circuit board designed for this project is double-sided but does not have through-plated holes. For this reason a number of components must be soldered at both sides of the board. In these cases there is a copper pad at each side. The parts in question are listed below and we suggest that these should be mounted first.

- One connection each for P1 and P7.
- One side of R2, R3, R4, R6, R7, R12, R15, R17, R20, R22, R24, R25, R28, R29, R37, and C20.
- The negative side of C1, C2, C15 and C19.
- The positive side of C17 and C21.
- The collector of T3 and T5.
- The emitter of T2.
- Both sides of C16, C18 and D8.
- Two connections each of P5, P9 and IC4.
- One connection of IC5, S2 and the DC OUTput.
- Finally, there are two pairs of connections through the board near both IC2

and IC3. These consist of four wires inserted in the appropriate holes and soldered at both sides.

The connection points for the potentiometers (P2, P8 and P9), the sockets, the transformer and switch S2 can be fitted with soldering pins. Those for P2, P8, P9 and the transformer are fitted on the reverse side of the board, the others on the component side. Make sure that the 'collar' on the pins is not too wide or it may cause short circuits on the board.

The MKT capacitors are mounted slightly above the board to prevent shorts. The potentiometers must also be mounted carefully so that they do not foul any other components.

The voltage regulators, IC4 and IC5, are placed on the reverse side of the board, with the metal mounting base facing P2. Each of these ICs must be fitted with a heatsink, or they may both be mounted on a piece of aluminium of about 60 × 100 mm (and 1.5 mm thick) as we have done. In either case the ICs must be electrically isolated from the heatsink(s).

There are numerous different types of rotary wafer switches that could be used for this project. If the switches used have a movable detent so that only the number of ways needed can be switched it is advisable to use this.

As in our other 'test equipment series' projects the printed circuit board is dimensioned to fit snugly in a Verobox (number 075-01411D, 205 × 140 × 75 mm). The corners of the board must be filed a bit to make it fit perfectly into the slots provided in the case. The project is given a very attractive appearance by the self-adhesive front panel foil that should be stuck onto the case. The appropriate holes should be drilled beforehand. The 'power' LED and the VCO socket are stuck onto the back of the front panel using two-component adhesive. The photographs clearly show how all the hardware fits together. The fact that all the electronics fits onto a single printed circuit board greatly simplifies matters.

Calibration

Not all the presets are accessible after the

5

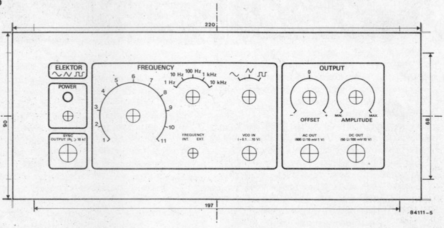


Figure 5. This front panel gives the project an attractive finished appearance. Before sticking the foil to the Verobox's aluminium panel all the holes must be drilled.

6

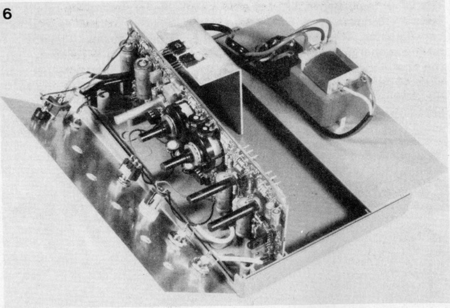
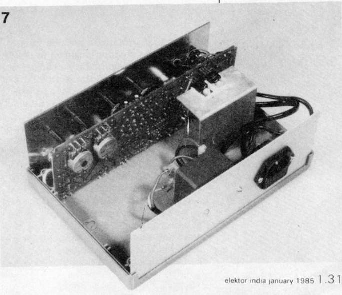


Figure 6. This is how the function generator is put together. Front panel, printed circuit board and back panel simply slide into grooves in the case (if the right Verobox is used). The switches, potentiometers and sockets are fitted to the front panel. Transformer and a fuse holder, and possibly a socket for the power, are mounted on the back panel.
N.B.: It is very important to insulate the power switch well (and ideally the transformer connections also) as there is a danger of it touching C19 or C22.

circuit has been fitted into the case so it is easier to calibrate them first. Connect the power transformer temporarily and before switching on set the presets as follows: Turn P8 fully right (maximum amplitude), all other pots and presets to mid-position, S2 closed, S3 set to square wave (c) and S1 to the 1...11 kHz range (d).
The power may now be applied. Connect a multimeter (with the most sensitive d.c. range selected) to the DC OUTput and set P9 so that the meter reads zero volts. Measure and note the peak to peak voltage of the square wave at this output with an oscilloscope.
The triangle wave is then selected with S3 (position b) and the peak to peak voltage is again measured. This value is trimmed with P6 until it is the same as that just measured for the square wave. At the same time the d.c. voltage at the output (seen on the multimeter) is set to zero volts with P5. Repeat this adjustment of P5 and P6 a few times until both amplitude and d.c. voltage are correct.
The sinewave is now selected by means of S3 (position a) and presets P4 and P7 are then used to reduce the distortion as much as possible. A distortion meter could be used for this but it is also possible to set it up 'by eye'. Turn P4 and P7 and see how they effect the waveform on the oscilloscope.
The final calibration involves setting the scale division. The front panel should be placed on the printed circuit board, taking care not to cause any short circuits, and a suitable knob is fitted onto P2. The knob should be fitted onto the spindle in such a way that the whole range of the scale can be scanned. Turn P2 until it points exactly towards '1' on the scale and then set the frequency to exactly 1 kHz with P1, measured with an oscilloscope or frequency meter. The knob is then turned to '10' and the frequency is set to 10 kHz by means of P3.
The other ranges are then automatically calibrated, as far as the tolerances of C3...C8 allow. If 5% capacitors are used the ranges are accurate to within 5%. An exception to this is C3 plus C4. The nominal value of the resultant capacitor is already 10% too large (as it is 11 μF instead of 10 μF) and the electrolytics have a tolerance of −10/+50%. Experimenting with different electrolytics should enable this lowest range to be made accurate. Perfectionists can also test the tolerance of the other capacitors (this is child's play using the Elektor capacitance meter). Furthermore cermet presets could be used for P1 and P3, and metal film resistors for R2, R9 and R10. A small frequency meter could also be made to give a direct readout of the function generator's output. None of this is strictly necessary, however. The original intention was to make a straightforward test instrument and that is what this is without all the extras. ◘

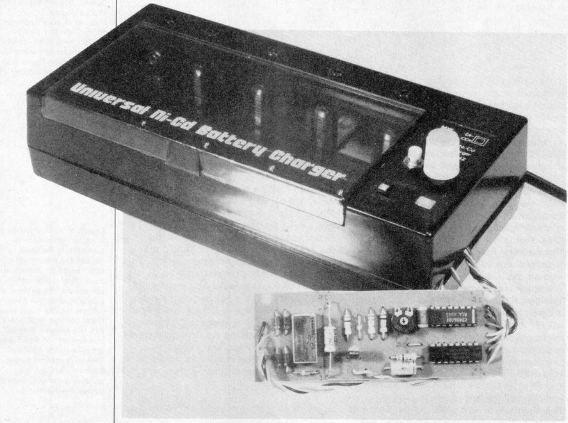
Figure 7. In this photo the function generator is completely finished, except for the lid which still has to be put on the case. The mains cable travels via the printed circuit board to the power switch on the front panel. Both voltage regulators (on the reverse side of the board) are fixed onto a home-made heatsink. The wire-wound potentiometer for the frequency setting is located under the heatsink.

7



The usual inexpensive NiCd chargers available in electronics retail outlets are normally of Far Eastern origin, but that in itself is of little consequence. They often suffer the disadvantage, however, of not having a charging time control. You therefore have to keep an eye on the charging times and this may be done with an ordinary alarm clock. This is not the answer, however, if you want the charging to be done while you're away. In that case, you could not do much better than build the inexpensive time switch described here: it is so small that it can readily be fitted inside the housing of most chargers.

time switch . . .



. . . for NiCd chargers

The circuit diagram of a popular inexpensive NiCd charger is shown in figure 1. Here, the NiCd batteries are charged from half-wave rectified and transformed-down mains voltage. Four 1.5 V cells and one 9 V battery may be charged simultaneously: two of the four 1.5 V cells on the positive half cycle and the other two on the negative half cycle. The 10 ohm and 270 ohm resistors limit the charging currents to safe values. The LEDs (light-emitting diodes) indicate that the cell or battery is being charged. If one of them does not light, it indicates that (a) the battery or cell is not seated properly in the holder, or (b) that the battery or cell is defect and therefore not charging, or (c) that the LED is malfunctioning.

The circuit diagram of the timer switch is shown in figure 2: it consists essentially of ICs 1 and 2 and a relay. To prevent the transformer having to supply the charging current as well as the current to operate the relay, the relay does not draw current during the charging period. The quiescent current for the time switch amounts to only 200 μA! The supply voltage for the circuit is obtained by full-wave rectification of the second of the three available transformer secondaries, and smoothing the pulsating direct voltage with C3. (The transformer is, of course, that already available in the charger).

The timer clock frequency (36 Hz) is generated by oscillator R1/R2/P1/C1 and the relevant parts of IC1. Integrated circuit 1 also contains a divider chain of which here the :1024 branch (available at

pin 15) is used. The divided-down clock of 36/1024 Hz is further divided so that charging times of ½, 1, 2, 4, 8, and 16 hours are available, depending on the setting of switch S1.
After the set time has lapsed, a logic high appears at the wafer of S1 (terminal M). Transistor T1 is then switched on, and the relay, Re1, is actuated. The logic high signal also causes the oscillator to stop via D5.
When the relay is inactive, its contacts connect A to B (see also figure 1), and charging current can flow; when it is actuated, the connection A-B is broken, and no charging current can flow.
It is, of course, not always convenient to keep plugging in and unplugging the mains supply to the charger, and yet it has to be possible to override the relay and switch the charging current on again. For this purpose, spring-loaded RESET switch S2 has been provided.

Construction

If the time switch is constructed on the printed circuit board shown in figure 3, no special problems should arise. Be sure, however, to use the correct relay. Once the board is ready, a place should be found for it in the charger.
It should in virtually all instances be possible to mount switches S1 and S2 on the front panel of the charger. Make sure, however, that their terminals are accessible for soldering after installation. Connection between them and the printed circuit should be made in not too thin insulated stranded wire.

1

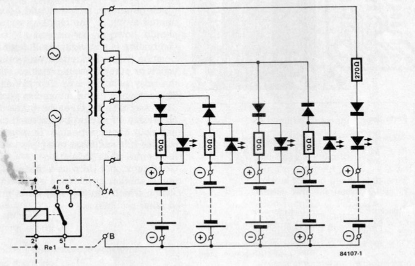


Figure 1. Circuit of a typical, popular NiCd battery charger. It allows the simultaneous charging of four 1.5 V cells (of various sizes) and one 9 V battery. The time switch is connected between points A and B.

2

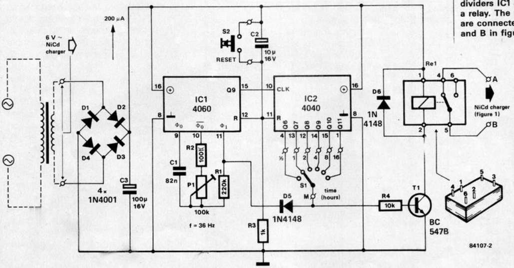


Figure 2. The circuit of the time switch consists essentially of binary dividers IC1 and IC2 and a relay. The relay contacts are connected to points A and B in figure 1.

3

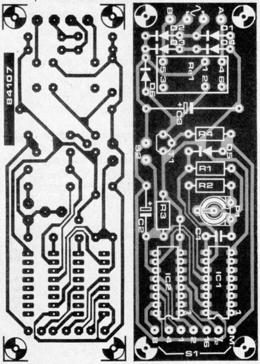


Figure 3. Component layout and track side of the printed circuit board.

Parts list

Resistors:
R1 = 220 k
R2 = 100 k
R3 = 1 k
R4 = 10 k
P1 = 100 k preset

Capacitors:
C1 = 82 n
C2 = 10 µ/16 V
C3 = 100 µ/16 V

Semiconductors:
D1 . . . D4 = 1N4001
D5,D6 = 1N4148
T1 = BC 547B
IC1 = 4060
IC2 = 4040

Miscellaneous:
S1 = miniature single-pole 6-position rotary switch
S2 = miniature spring-loaded push-button, push to make
Re1 = miniature relay for PCB mounting, single-pole change-over, 6 V, 360 Ω
Printed circuit board 84107

Table 1. Divisors available in the 4040

Pin	Divisor
1	2^{12} = 4096
15	2^{11} = 2048
14	2^{10} = 1024
12	2^{9} = 512
13	2^{8} = 256
4	2^{7} = 128
2	2^{6} = 64
3	2^{5} = 32
5	2^{4} = 16
6	2^{3} = 8
7	2^{2} = 4
9	2^{1} = 2

Table 2. Divisors available in the 4060

Pin	Divisor
3	2^{14} = 16384
2	2^{13} = 8192
1	2^{12} = 4096
15	2^{10} = 1024
13	2^{9} = 512
14	2^{8} = 256
6	2^{7} = 128
4	2^{6} = 64
5	2^{5} = 32
7	2^{4} = 16

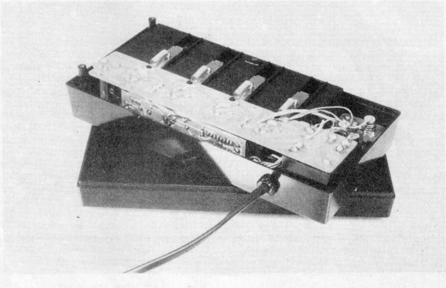
Finally, the (earth) return line in the charger should be broken to provide points A and B; where this is done depends on the location of the time switch: the connections should be kept as short as possible.

Different chargers, of course, call for different considerations. It is also possible to give the time switch its own mains transformer with a 6 V_{rms} secondary, and house both in one case to form a universal time switch. Universal, because it is possible by altering the values of the oscillator components to change the frequency. Moreover, it is possible to change the divide factors by using different pins on IC1 and IC2 (see tables 1 and 2).

If, for instance, you replace S1 by a single pole, 12-way rotary switch, and connect outputs Q3 . . . Q8 and Q11 . . . Q13 of IC1 to a 10-way rotary switch, all sorts of possible divide factors are obtained. Even more possibilities arise when the internal oscillator of IC1 is replaced by an external clock generator, which should be connected to pin 11. The clock frequency should, however, not exceed 1 MHz.

Calibration is simplicity itself. Set S1 to position '½' and ascertain with your wrist watch or other convenient clock whether the relay switches over after half an hour. The accuracy in the remaining positions of S1 may then be taken for granted. If necessary, P1 should be adjusted and the half hour check repeated. In most instances it is sufficient to simply set P1 to the centre of its travel.

Good luck, and drop us a line if you have found another application of the time switch which you feel may be of interest to other readers. ■



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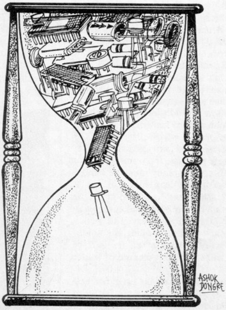
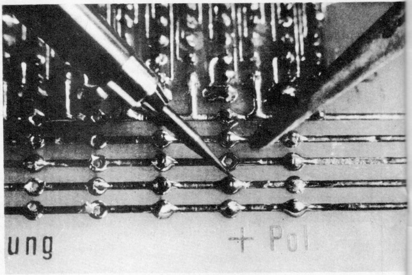


W. Schmidt

with a pencil point



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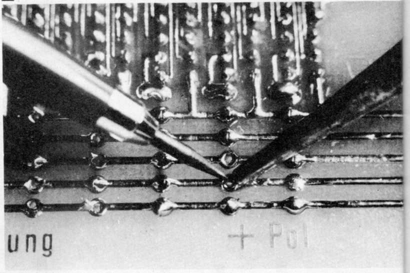

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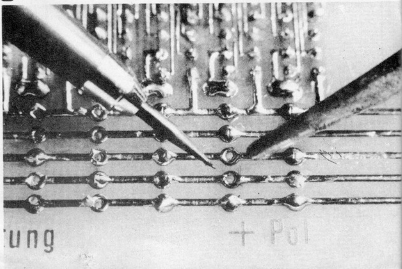
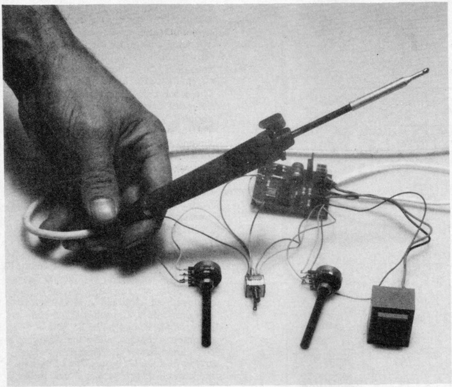


Many electronics enthusiasts look on solder removing as a loathsome job. This is especially true of printed circuit boards with narrowly-spaced conductors. Things which often happen when one is trying to desolder are:

- The solder forms bridges between the conductors.
- Blobs of solder drop off the board.

De-soldering tools or wicks are available commercially, but there is no need to lay out that kind of money. Any workshop toolbox should yield a really cheap device which will do the trick – a pencil. Propelling pencils with long leads of 2B or B hardness are particularly suitable (e.g. clutch pencils). To remove solder from a hole, the solder must be heated with a soldering iron until it melts (figure 1). The next step is to stick the pencil point in the hole, and take away the iron (figure 2). Where the pencil lead touches molten solder, the solder 'jumps' away, because of its surface tension, and the hole is cleared of solder (figure 3).

A similar method can be used for getting rid of bridges of solder between tracks. To do this, the pencil point is laid flat on the molten solder between the tracks.



give your soldering tip a longer life

with this economy circuit

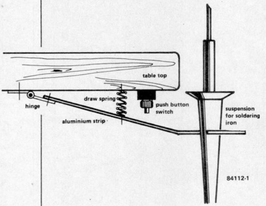
The life expectancy of the tip of a soldering iron may be increased substantially by heating the iron to full capacity only during actual use. To accomplish this, the input power to the iron is reduced during the periods the iron is resting on its stand. This is achieved by using only one half of each cycle of the mains voltage during the rest period.

Heating of the iron during half cycles of the mains voltage only is effected by connecting a suitable diode in series with the "live" mains conductor as shown diagrammatically in figure 1. A suitable actual arrangement of this is shown in figure 2. When the iron is suspended at rest, the spring-loaded switch is open, and the diode passes only one half of each mains voltage cycle. When the iron is lifted for use, the draw spring causes the switch to be closed by the aluminium strip: the diode is then short-circuited and full mains power is applied once more to the iron.
The fuse in series with the diode protects it during the transient caused by the closing of the switch. The neon lamp indicates when only half power is being supplied to the iron.
This type of arrangement has the advantage that it is suitable for use with any soldering iron, but it is almost twenty years old. Nowadays, pulse control instead of half-wave control us used.
In pulse control, the soldering iron is heated for only 50...90 per cent of the time the mains is on. The relation of the control pulses ($\overline{Q}$) to time is shown diagrammatically in figure 3: at the top the mains voltage, 240 V/50 Hz, under this the clock pulses derived from the mains, then the $\overline{Q}$ pulses which switch the heating element, next the voltage across time determining capacitor C2, and finally the part of the mains voltage actually used for heating.

Circuit description

The circuit of the soldering iron regulator, figure 4, is quite uncomplicated. In the following, the description is on the basis of figure 3.

1



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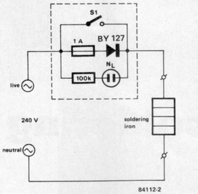


Figures 1 & 2. The old solution to the problem of overheating soldering tips: (1) mechanical layout; (2) electrical connections.

3

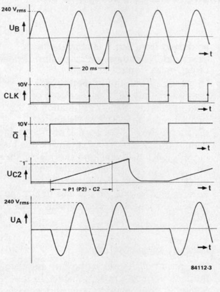


Figure 3. Waveform diagrams associated with the modern solution to the problem of overheating soldering tips.

The mains voltage, U_B, exists across terminals B. The circuit is closed via heating element A and power switch Tri1. The operating voltage for the control circuits is derived from a small transformer, Tr1, rectifier diode D1, and smoothing capacitor C1; it amounts to about 11 V.

The clock pulses are obtained as follows. First, the mains voltage is reduced to about 10 V_{rms} by voltage divider R1/R2. This voltage is then applied via current-limiting resistor R3 to the base of transistor T1. The transistor conducts during the positive half cycles of the applied voltage, which causes the voltage existing at the CLK input of bistable FF1 to be nullified. During the negative half cycles, diode D1 conducts, T1 is cut off, and the voltage at the CLK input of FF1 goes high again. All this happens at a frequency of 50 Hz.

The bistable is set ($\overline{Q}$ logic low) at the rising edge of the clock signal. Capacitor C2 is then discharged via R5 and D3. The clock pulse will reset FF1 so that output $\overline{Q}$ goes logic high; the level at input D remains logic 0. Capacitor C2 is then charged via P1 or P2 and R5. The diagrams in figure 3 show that charging is completed before the next rising edge arrives at the CLK input. This edge sets the bistable afresh so that $\overline{Q}$ becomes logic low again.

The charging time depends on the setting of P1 or P2: the time constant is a minimum 6.7 ms (R5C2) and a maximum 417 ms (R5 + P1)C2 or (R5 + P2)C2. This means that $\overline{Q}$ may be switched at frequencies of 50. . . 2.4 Hz, resulting in the supply of heating power between 50 and 95 per cent of the time. If the potentiometers are provided with end switches, it becomes possible to get heating power all the time. In our opinion, however, such switches are not necessarily a good thing, for although the consequent losses during use of the iron are negligible, they are not so during the rest periods.

The two potentiometers enable setting the heating power during the rest periods and the periods of use respectively. Switch S1 — which could be arranged as shown in figure 1 — selects either of the two states. The $\overline{Q}$ output signal of FF1 triggers the triac, Tri1, via transistor T2: the triac switches the soldering iron on and off. When T2 conducts, LED D4 lights, so that the blinking of this diode is a measure of the power being supplied to the iron: fast blinking means high average power, while a slow rate indicates low average power.

Construction

When printed circuit 84112 is used, the construction becomes almost child's play. Terminals A. . . D have been so arranged that two four-way spring-loaded terminals may be soldered to them: the four sets of connecting wires can then conveniently be clamped into them. The triac is a fully insulated type which means that none of its terminals is connected to the housing. The circuit is suitable for use with 240 V

4

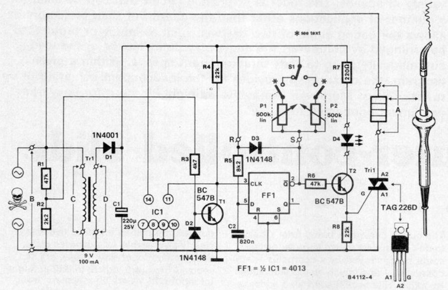


Figure 4. Circuit diagram of the economy unit.

5

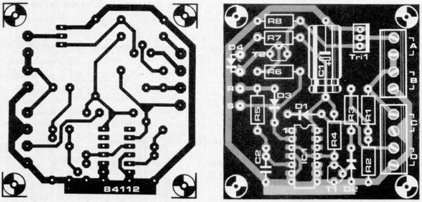


Figure 5. Printed circuit of the economy unit.

soldering irons of 15...1500 watts. It is also possible to control other resistive heating elements, such as immersion heaters, with the circuit. If, however, the circuit is used for the control of heating elements combined with a fan, such as hair dryers or fan-forced heaters, it becomes necessary to connect a 220-ohm resistor in series with a 47 nF/400 V capacitor across the triac.
No calibration is required: it is only necessary to set one potentiometer for the required power during the rest periods, and the other for the required power during use. Inevitably, this means that some compromise between the two requirements has to be found as on the one hand the power during the rest periods should not be so low that it takes too long for the iron to reach normal heat after being picked up for use, and on the other, that this power should not be so high that the tip of the iron overheats during the rest periods.
As already stated, switch S1 may be arranged as shown in figure 1.

Parts list

Resistors:
R1,R6 = 47 k
R2 = 2k2
R3 = 4k7
R4,R8 = 22 k
R5 = 8k2
R7 = 220 Ω
P1,P2 = 500 k linear potentiometer (if required, with end switch — see text)

Capacitors:
C1 = 220 µ/25 V
C2 = 820 n

Semiconductors:
D1 = 1N4001
D2,D3 = 1N4148
D4 = LED
T1,T2 = BC 547B
Tri1 = TAG 226 D
IC1 = 4013

Miscellaneous:
S1 = SPDT switch, if required push-button type
Tr1 = mains transformer, 9 V/100 mA secondary
2 four-pole spring-loaded terminals for PCB use
Printed circuit board 84112

The use of two slide projectors and this computer-controlled slide fader enables the pictures to fade into each other on the screen at a variety of speeds. The fader is a versatile circuit that can be used for a number of applications other than the control of slide projectors. It allows the gating angle of two devices, such as lamps or motors, to be arranged by computer: the angle may be increased or reduced automatically at up to sixty-three different speeds. Within a given program, the circuit also provides for the independent actuating of up to four relays. Moreover, it provides an eight-bit input for data from equipment connected to it.

computer-controlled slide fader. . .

. . .can also be used for phase gating other devices

The circuit came into being from a desire to design an easy-to-use slide fader that could be controlled by a computer — any computer — and which would fade slides smoothly. This necessitated filed address decoding and automatic control of the switch-on and fading of the projector lamps. Moreover, it was thought desirable for the projectors to be switched forward and backward independently of each other. To make this possible, it was found necessary for the circuit to be able to actuate four relays independently of one another. When all this had been incorporated, we had an interface that was clearly also usable for purposes other than the control of slide projectors. It seemed therefore logical to add an eight-bit input port via which messages from equipment connected to the interface could be read.

Block diagrams

A schematic view of the complete circuit is shown in figure 1. The complete address bus, AØ. . .A15, and the required control bus connections are taken direct

1

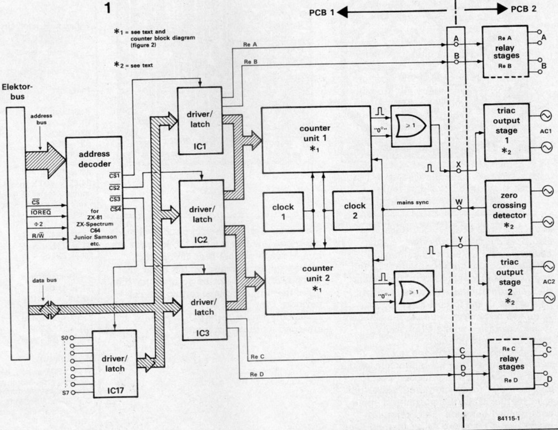


Figure 1. This block diagram gives a clear view of the function of the complete circuit.

2

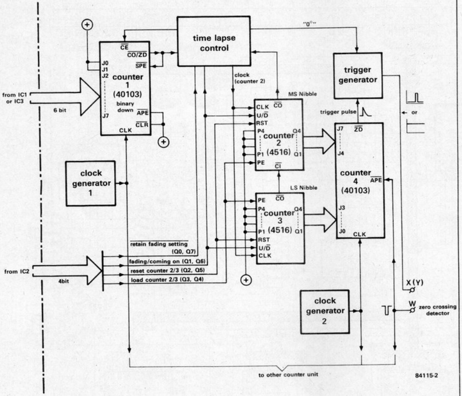


Figure 2. The counter units in figure 1 consist of three interconnected counters the function of which is represented in this diagram.

to the address decoder. Examples of the decoding with the ZX81, ZX Spectrum, Commodore C64, and the Junior (with extension bus) are given later in this article. The address decoder generates four $\overline{CS}$ signals which select eight-bit memory units: three output and one input. Writing into the output memories and reading the contents of the input memory takes place via the data bus.

The four relays are controlled via two lines of two output ports; all other lines of the output ports are used for the programming of the two counters. These counters, synchronized with the mains frequency by a zero crossing detector, are the real heart of the circuit in that they provide the desired phase shift and generate the trigger pulses for the triacs. A special output stage enables these triacs to fire very close to the zero crossing of the mains frequency.

The triac output stages are electrically isolated from the control stages by optocoupler. They have been arranged so that they may be connected to different a.c. supplies. The two supplies must, of course, be in phase or anti-phase.

The schematic in figure 2 shows the counters in more detail. It should be noted that the terms "fading", "coming on", and "fading speed" used in the following apply, strictly speaking, to lamps only: in the case of motors, these should be "reducing speed", "increasing speed", and "rate of reduction, or increase, of speed" respectively. In proper technical terminology, we should have used "increasing, or decreasing, gating angle", but that might have become too confusing.

Counter 1 is loaded with the fading speed by the computer, and counts downwards. When counter position "0" is reached, a clock pulse is given to counters 2 and 3 via the time lapse control stage, while counter 1 is loaded again with the content of the memory unit (which makes it possible for the fading speed to be altered during fading or coming on). Counters 2 and 3, both type 4516, are connected in cascade and thus form a composite counter. The direction of counting is reversed via $U/\overline{D}$. During the coming on period of the lamp, the counter is loaded by a pulse on PE with bit pattern 1111 1111, and switched to downward counting via $U/\overline{D}$. During fading, counter 2/3 is reset to ØØØØ ØØØØ by a pulse at RST, and switched to upward counting via $U/\overline{D}$.

Counter 4 is triggered by the zero-crossing detector, loaded with the actual content of counter 2/3, and then counts downward from that content. As soon as counter position "0" has been reached, the $\overline{ZD}$ (zero detect) output is actuated, and this causes the trigger generator to impart a pulse to the triac. At the same time, the clock output is disabled. On the next pulse from the zero crossing detector, this process repeats itself, and so on.

3

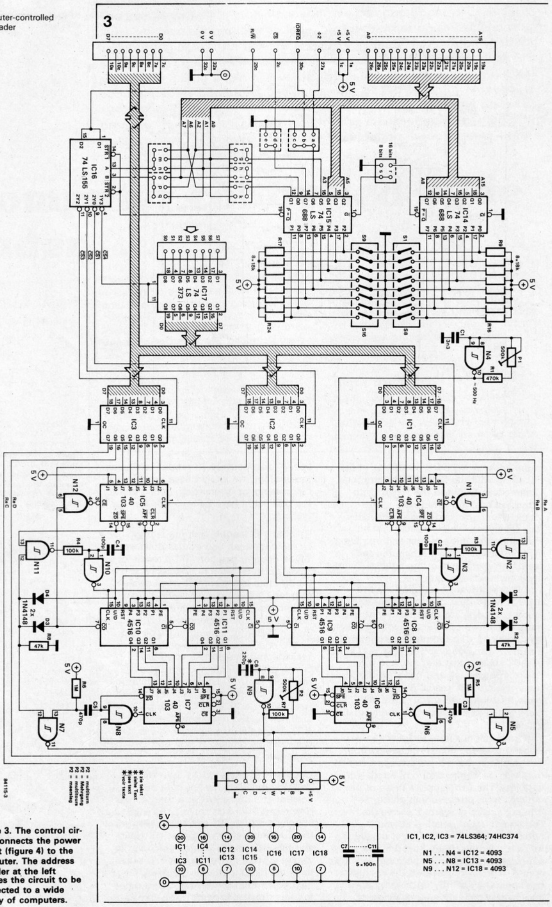


Figure 3. The control circuit connects the power circuit (figure 4) to the computer. The address decoder at the left enables the circuit to be connected to a wide variety of computers.

4

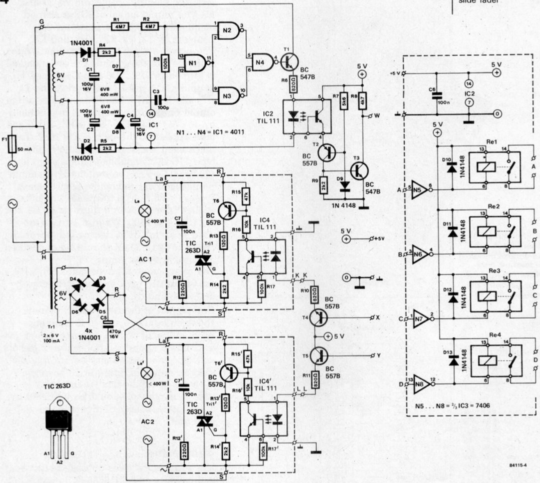


Figure 4. Apart from the triacs and associated components, the power circuit also contains the zero crossing detector and the four relays with their drivers. This board may be cut into parts.

The content of counter 2/3 keeps on changing, of course, as this counter is clocked by counter 1.
Summarizing, counter 1 functions as programmable clock generator for counter 2/3, while the content of counter 2/3 is loaded into counter 4 to determine the phase gating angle.
The time lapse control stage ensures that the lamp stays on after coming on, and remains out after fading, until a new program is used, and that at the onset of fading the lamp does not prematurely extinguish.

Circuit diagrams

The circuit of the control board is shown in figure 3, that of the triac board in figure 4. Starting with figure 3, the address decoder for the various computers will be discussed a little later on. Integrated circuit 17 is an input port which is actuated by $\overline{CS}$4. The three output ports are formed by IC1...IC3: the number of the port corresponds with that of the IC. Outputs Q6 and Q7 of IC1 and IC3 serve to control the relays. Outputs QØ...Q5 of the same ICs are used for programming the fading speeds of counter 1 and counter 2 respectively.
The arrangement of the remainder of the stages in figure 3 as compared with the block diagram of figure 2 is as follows (counter 2 in brackets):
counter 1 = IC4 (IC5);
counter 2/3 = IC8/IC9 (IC10/IC11);
counter 4 = IC6 (IC7);
time lapse control = N1...N3, D1, D2, R2, R3, C2 (N10...N12, D3, D4, R4, R8, C4);
trigger generator = N5, R5, C3 (N7, R6, C5);
clock oscillator 1 = N4, R1, P1, C1;
clock oscillator 2 = N9, R7, P2, C6.
Control of counters 1 and 2 is provided by IC2: QØ...Q3 for the former and Q7...Q4 for the latter (the single port lines are shown in figure 2).
Note that the 0° line in figure 2 becomes logic 0 when the desired gating angle is 0° (maximum power): the output of N5 (N7) is consequently logic 1 during the entire following half cycle.
On the triac board shown in figure 4, D1, D2, D7, D8, C1, C2, C4, R4, and R5 form the power supply for the zero crossing detector. This detector itself consists of N1...N4, R1...R3, and C3, and drives

5

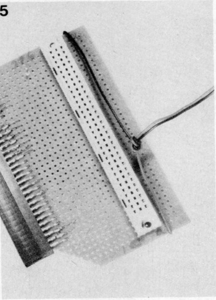
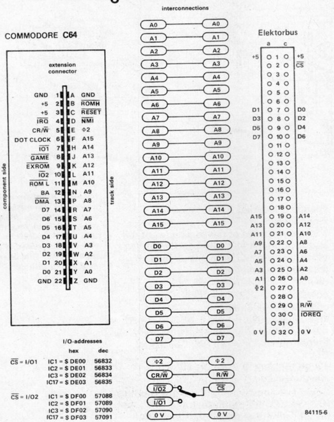


Figure 5. Photograph of the adapter which interfaces the control circuit with the relevant computer. Shown here is the adapter for use with the ZX Spectrum.

6



state of bridges

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
o	o	x	x	o	x	o	o	x	x	o	o	x	o	o	o	x	x	o

x = closed
o = open

switch positions

S	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
I/O1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	0
I/O2	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0

1 = closed
0 = open

Figures 6, 7, and 8. The I/O addresses, the extension connector pin-out, the necessary interconnections to the elektor-bus, the state of the wire bridges, and the switch positions are shown here for use with...
...the Commodore C64 (figure 6)

opto-coupler IC2, which provides the required electrical isolation, via T1 and R6. The output signal of IC2 is shaped into a clean low-active pulse for the counters by T2, T3, R7...R9, and D9.
The power supply for the two triac stages, which — like the counters — are identical, is formed by D3...D6 and C5. Opto-couplers IC4 and IC4' are driven by T4 (T5) and R10 (R11). The trigger pulse at the output of the opto-coupler is regenerated by T6 (T6') and R13...R17 (R13'...R17') and then applied to the gate of the triac. The triacs used are of medium heavy duty type TIC 263C, enabling lamps of up to 400 W (at 24 V) to be switched: maximum permissible current (with resistive loads) $I_{T(rms)}$ = 25 A. The triacs are protected against spurious surge currents by C7 and R12 (C7' and R12'). When the triacs are used to switch 240 V lamps, a suppressor choke of 30...50 μH should be connected in series with the lamps.
The relays, controlled via gates N5...N8, are of the DIL type, and are protected by free-wheeling diodes D10...D13.
Completion of the two printed circuits shown in figures 9 and 10 is straightforward and is, of course, to some extent dependent upon the application of the circuit. The triac board may be suitably divided as shown in figure 10. In any case, the parts of the boards where mains voltage is present should be insulated by, for instance, a layer of glue applied with a glue gun.

Addressing

The address decoder consists of two 8-bit comparators type 74LS688 (IC14 and IC15), a 2-bit binary decoder and demultiplexer type 74LS155 (IC16), a number of wire bridges, a...s, and sixteen switches, S1...S16, contained in two 8-way DIL packages.
The two 74LS688s compare the information set by the switches with the bit pattern at their inputs QØ...Q7. If the two sets of data are identical, output $\overline{P = Q}$ (pin 19) becomes logic low. The two ICs may be cascaded by closing wire bridge "r" to give a 16-bit comparator. If wire bridge "s" is closed, only IC15 is active (as 8-bit comparator). The output (pin 19) of IC15 provides the strobe signal for IC16.
Two-bit information is applied to data inputs P and Q of IC16. Switch-over of the on-board data dividers is effected via the R/$\overline{W}$ line: if the line is logic high, and the information at P and Q "11", $\overline{CS4}$ becomes active (writing); if the R/$\overline{W}$ line is logic low, $\overline{CS1}$ is actuated when the information at P and Q is "00", $\overline{CS2}$ when the information is "10", and $\overline{CS3}$ when the information is "01".
Tables 1 and 2 give the state of the wire bridges and switches respectively for use with the Junior computer. If the Extended Junior is used, the control board can be plugged direct into the extension bus. We have taken the Junior as an example for the addressing and will deal with the

Table 1.

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
elektorbus (Junior)	x	o	o	o	x	x	o	o	x	x	o	o	x	o	o	o	x	x	o

x = bridge closed
o = bridge open

Table 1. State of the wire bridges when the Junior computer is used.

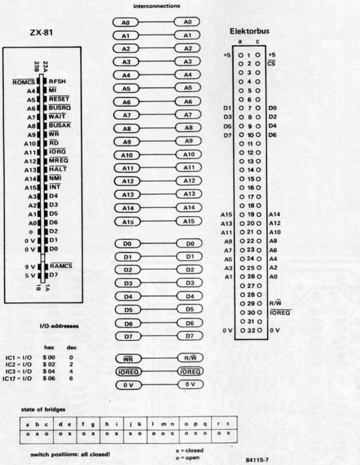
Table 2.

	Switch															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
elektorbus (Junior)	x	x	x	o	o	o	x	o	o	o	o	o	x	x	o	o

x = switch closed
o = switch open

Table 2. Switch positions when the Junior computer is used.

7



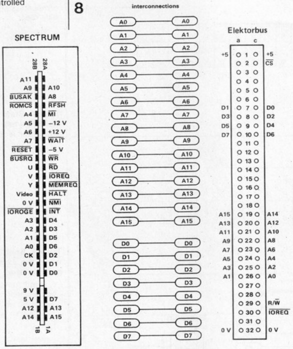
...the ZX81 (figure 7)

other three computers further on. The two lowest-value address lines are connected to the data inputs of IC16 via bridges "m" and "q". Bridge "r" enables IC14 and IC15 to be combined into a 16-bit comparator. Address lines A2, A6, and A7 are connected to the comparator via bridges "f", "j", and "i" respectively. Inputs Q6 and Q7 of IC15 are connected to earth via bridges "c" and "e", which necessitates the closing of switches S13 and S14. All this results in the decoding of

- $\overline{CS1}$ by address E200 (decimal 57 856);
- $\overline{CS2}$ by address E201 (decimal 57 857);
- $\overline{CS3}$ by address E202 (decimal 57 858);
- $\overline{CS4}$ by address E203 (decimal 57 859).

A caution here: if, in the Junior, you have placed RAM in block E (addresses E000...EFFF), this RAM must be deselected to avoid double addressing.

8



I/O-addresses

	hex	dec
IC1	FF3E	65342
IC2	FF7E	65406
IC3	FFBE	65470
IC17	FFFE	65534

state of bridges

a b c	d e	f g	h i	j k	l m n	o p q	r s
o o x	x o	x o	x o	o x	x o o	x o o	x o

x = closed
o = open

switch positions

S	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

1 = closed
0 = open

84115-8

...the ZX Spectrum (figure 8)

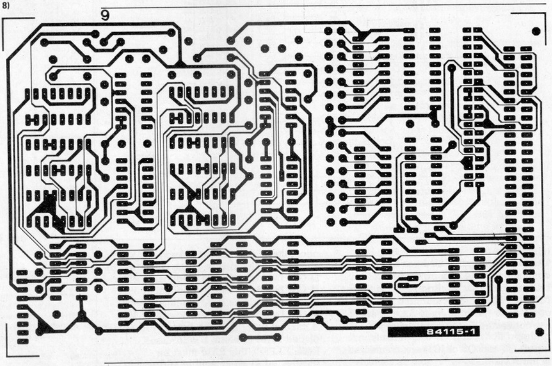
The three other computers (with the possible exception of the ZX81 — see below) require a simple adapter to interface their extension connection ("User Port") with the Elektor bus. This adapter is made from a plug which fits the User Port of the relevant computer, a 64-way female connector, and a small Veroboard. The board should be cut to the correct size to enable the plug and socket to be soldered to it. Appropriate connections are then made between the plug and socket with short lengths of insulated wire. The photograph in figure 5 shows our prototype adapter for the ZX Spectrum. The two long pieces of wire are for connections to an external +5 V supply. Depending on the rating of the power supply in the computer, it may be possible to draw the required power from this supply.

Figures 6, 7, and 8 show the pin out of the user port, the required connections between the plug and socket, the pin out of the Elektor bus (64-way female connector), the wiring of the bridges, and the switch positions for the C64, ZX81, and ZX Spectrum respectively.

If a C64 without floppy disk drive is used, it is possible with the change-over switch in the adapter to choose between output signals $\overline{I/O1}$ and $\overline{I/O2}$, and consequently between addresses DE00...DE03 and DF00...DF03. If a floppy disk drive is fitted, the switch must be set to $\overline{I/O1}$, and only address DE00...DE03 are then available. It is in that case, of course, possible to replace the switch by a fixed wire bridge.

If a ZX81 is used, the bus buffer described in the July 1984 issue of *Elektor* India (page 7-22) may be used instead of the adapter. Terminals 31a and 29c of the buf-

9



fer board should then be interconnected. Finally, the adapter shown in figures 6, 7, and 8 may, of course, also be used to connect other Elektor bus boards to the respective computers.

Programming

The primary task of the programming is the writing of the data into IC2: this determines the operation of the two counters. The bit on data line DØ matches that at the IC output QØ, that on D1 matches that at Q1, and so on. The significance of the single bits is (counter 2 lines in brackets):

- DØ (D7): if this line is logic high, automatic fading is selected; if it is low, the prevailing fading state is retained;
- D1 (D6): the state of this line determines whether the relevant lamp is coming on (logic 0) or fading (logic 1);
- D2 (D5): if this line is logic high, composite counter 2/3 is reset;
- D3 (D4): when this line is logic 1, composite counter 2/3 is loaded with bit pattern "1111 1111".

The slide control program contains the bit patterns of the only four practical

Figure 9. The printer circuit board for the control circuit.

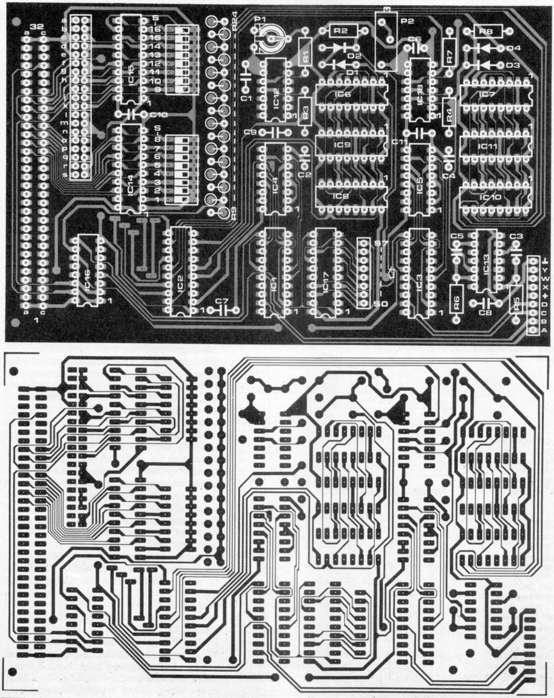
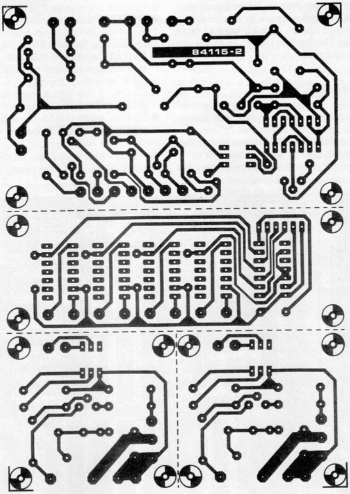


Figure 10. The printed circuit board for the power circuit. This board may be cut into parts which may then be fitted in the housing of the equipment being controlled (cut at dashed lines).

10



Parts list — control board

Resistors:

R1 = 470 k
R2,R8 = 47 k
R3,R4,R7 = 100 k
R5,R6 = 1 M
R9...R24 = 18 k
P1 = 500 k preset
P2 = 500 k preset, multiturn

Capacitors:

C1 = 3n3
C2,C4 = 100 p
C3,C5 = 470 p
C6 = 220 p (see text)
C7...C11 = 100 n

Semiconductors:

D1...D4 = 1N4148
IC1...IC3 = 74LS364 (74HC374)
IC4...IC7 = 40103
IC8...IC11 = 4516
IC12,IC13,IC18 = 4093
IC14,IC15 = 74LS688 (74HC688)
IC16 = 74LS155
IC17 = 74LS373

Miscellaneous:

2 SPST octal DIL switches
64-way male connector
Miniature tag board with two rows of 19 tags each
Miniature tag board with one row of 17 tags
8 shorting plugs
Printed circuit board 84115-1

Table 3. Bit patterns of the only four practical operating states of each of the two lamps.

Table 3.

	D3 (D4)	D2 (D5)	D1 (D6)	D0 (D7)
on	0	1	0	1
off	1	0	0	1
coming on	0	0	0	1
fading	0	0	1	1

Table 4. The bit patterns of table 3 may form sixteen data words for programming the fading and coming on behaviour of the two lamps.

Table 4.

	D7	D6	D5	D4	D3	D2	D1	D0	dec.	hex
both lamps on	1	0	1	0	0	1	0	1	165	A5
A on, B off	1	0	0	1	0	1	0	1	149	95
A off, B on	1	0	1	0	1	0	0	1	169	A9
both lamps off	1	0	0	1	1	0	0	1	153	99
both lamps coming on	1	0	0	0	0	0	0	1	129	81
A off, B coming on	1	0	0	0	1	0	0	1	137	89
A on, B coming on	1	0	0	0	0	1	0	1	133	85
A coming on, B off	1	0	0	1	0	0	0	1	145	91
A coming on, B on	1	0	1	0	0	0	0	1	161	A1
both lamps fading	1	1	0	0	0	0	1	1	195	C3
A off, B fading	1	1	0	0	1	0	0	1	201	C9
A on, B fading	1	1	0	0	0	1	0	1	197	C5
A fading, B off	1	0	0	1	0	0	1	1	147	93
A fading, B on	1	0	1	0	0	0	1	1	163	A3
A fading, B coming on	1	0	0	0	0	0	1	1	131	83
A coming on, B fading	1	1	0	0	0	0	0	1	193	C1

operating states of each lamp: on, off, coming on, fading: these patterns are given in table 3. The complete circuit (that is, two lamps) therefore offers sixteen possible combinations which are listed in table 4. Our master programs have been so arranged that no confusion is likely to arise. If you design your own program, take care that it runs sensibly. You may, for instance, want to interrupt during fading, or reverse the direction during fading or coming on, or something similar. Such operations have not been catered for in our programs to keep them to a reasonable length.

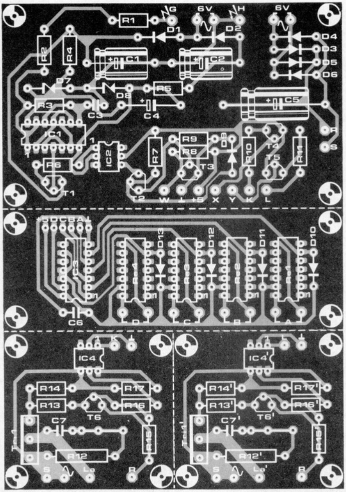
An example, using the Junior: it is required that lamp A comes on and that lamp B is and stays off. It is then necessary to write bit pattern 1001 0001 (= decimal 145) into IC2, address E201 (= decimal 57857). The instruction for this is:

POKE 57857, 145

In the case of the C64, this command would be:

POKE 57089, 145 or POKE 56833, 145

When programming the fading speed and actuation of the relays, bear in mind that these are arranged in one IC (IC4 or IC5). If the relays are not needed, matters are



Parts list — power board

Resistors:

R1,R2 = 4M7
R3,R17,R17' = 100 k
R4,R5,R9,R14,R14' = 2k2
R6,R10,R11 = 820 Ω
R7 = 5k6
R8 = 4k7
R12,R12' = 220 Ω (1 W for 240 V supplies)
R13,R13' = 120 Ω
R15,R15' = 47 k
R16,R16' = 10 k

Capacitors:

C1,C2 = 100 μ/16 V
C3 = 100 p
C4 = 10 μ/16 V
C5 = 470 μ/16 V
C6 = 100 n
C7,C7' = 100 n (400 V rating for 240 V supplies)

Semiconductors:

D1...D6 = 1N4001
D7,D8 = 6V8/400 mW
D9...D13 = 1N4148
T1...T5 = BC 547B
T6,T6' = BC 557B
Tri1,Tri1' = TIC 263D
IC1 = 4011
IC2,IC4,IC4' = TIL 111
IC3 = 7406

Miscellaneous:

Re1...Re4 = DIL relay, 1 pole make, 5 V coil
Tr1 = mains transformer, secondary 2 x 6 V/100 mA
F1 = 50 mA fuse, delayed action
Printed circuit board 84115-2

simple: you write with a POKE command a decimal number between 1 and 63 into IC1 (IC3). Examples:
Junior computer, lamp A, medium fading speed:
POKE 57856, 31
C64, lamp B, maximum fading speed:
POKE 57090, 1
ZX Spectrum, lamp A, minimum fading speed:
OUT 65342, 63
As you see, the smaller the number, the higher the speed. Note, however, that the command
POKE nnnnn, 0
is not possible, because counter 1 — see figure 2 — then cannot operate.
The two highest-value bits are always logic 0 for decimal numbers between 0 and 63. Table 6 shows how the relays may be controlled: when it is required that relay A (IC1) or relay C (IC3) be actuated, a decimal number between 129 and 191 should be selected. The correct number is calculated by adding 128 to the value of the wanted fading speed. The instruction in the first of the above examples would then be:
POKE 57856, 159
If only relay B is to be actuated, add 64 to the value of the required fading speed. If both B and D are to operate, add 192 to the value of the fading speed. In all cases, decimal numbers 0, 64, 128, and 192 are not permitted, because bits 0...5 are logic low so that the clock generator is disabled.
Table 6 shows a menu-controlled program for the Junior and C64 which enables the reading or programming of the collective functions of the circuit by entering code numbers. The program as printed is correct for the Junior: for the C64, line 2050 should be altered as shown in table 7. Lines 1Ø...19ØØ are explained in the foregoing: the remainder of the lines arrange for the automatic control of the relays, so do not again program them!
Tables 8 and 9 give a short sample pro-

Table 5.

relay A (C) = bit 7	relay B (D) = bit 6	fading speed bit 5...bit 0	decimal range
0	0	x x x x x x	1...63
1	0	x x x x x x	129...191
0	1	x x x x x x	65...127
1	1	x x x x x x	193...255

Table 5. Bit patterns for the control of the relays.

```
10 REM control program slide fader
20 DIM P(2):T1=5:A=57856:B=57857:C=57858:AS=10:BS=10
30 PRINTTAB(T1):" main menu :":PRINT
40 PRINTTAB(T1):" 1) setting the fading speed "
50 PRINTTAB(T1):" 2) both lamps on "
60 PRINTTAB(T1):" 3) lamp A on. lamp B off "
70 PRINTTAB(T1):" 4) lamp A off. lamp B on "
80 PRINTTAB(T1):" 5) both lamps off "
90 PRINTTAB(T1):" 6) both lamps coming on "
100 PRINTTAB(T1):" 7) lamp A off. lamp B coming on "
110 PRINTTAB(T1):" 8) lamp A on. lamp B coming on "
120 PRINTTAB(T1):" 9) lamp A coming on. lamp B off "
130 PRINTTAB(T1):"10) lamp A coming on. lamp B on "
140 PRINTTAB(T1):"11) both lamps fading "
150 PRINTTAB(T1):"12) lamp A off. lamp B fading "
160 PRINTTAB(T1):"13) lamp A on. lamp B fading "
170 PRINTTAB(T1):"14) lamp A fading. lamp B off "
180 PRINTTAB(T1):"15) lamp A fading. lamp B on "
190 PRINTTAB(T1):"16) lamp A fading. lamp B coming on "
200 PRINTTAB(T1):"17) lamp A coming on. lamp B fading "
201 PRINTTAB(T1):"18) control of relays "
210 PRINTTAB(T1):"19) Stop.":PRINT:PRINT
220 INPUT" write in choice (1...19)":K
230 IF K>0 AND K<19 GOTO 250
231 IF K=19 THEN END
240 PRINT" invalid value! write in anew! ":PRINT:PRINT:GOTO30
250 ON K GOTO 300.400.500.600.700.800.900.1000.1100.1200
260 ON K-10 GOTO 1300.1400.1500.1600.1700.1800.1900.2000
300 INPUT " write in fading speed of lamp A (1-63):":SA
310 IF SA<1 OR SA>63 THEN GOTO 300
360 POKE A.SA
370 INPUT " write in fading speed of lamp B (1-63):":SB
380 IF SB<1 OR SB>63 THEN GOTO 370
390 POKE C.SB:GOTO 30
400 POKE B.165:GOTO 30
500 POKE B.149:GOTO 30
600 POKE B.169:GOTO 30
700 POKE B.153:GOTO 30
800 POKE B.129:GOTO 30
900 POKE B.137:GOTO 30
1000 POKE B.133:GOTO 30
1100 POKE B.145:GOTO 30
1200 POKE B.161:GOTO 30
1300 POKE B.195:GOTO 30
1400 POKE B.201:GOTO 30
1500 POKE B.197:GOTO 30
1600 POKE B.147:GOTO 30
1700 POKE B.163:GOTO 30
1800 POKE B.131:GOTO 30
1900 POKE B.193:GOTO 30
2000 GOSUB 6000:PRINTTAB(T1):" slide change menu:":PRINT
2010 PRINTTAB(T1):"1) projector A forward "
2020 PRINTTAB(T1):"2) projector A backward "
2030 PRINTTAB(T1):"3) projector B forward "
2040 PRINTTAB(T1):"4) projector B backward "
2050 PRINTTAB(T1):"5) revert to main menu ":PRINT:PRINT
2060 INPUT" write in choice (1...5) ":K
2070 IF K<1 OR K>5 THENPRINT" wrong choice! write a new! ":GOTO2000
2080 ON K GOTO 2100.2300.2500.2700.30
2100 POKE A.(AS+128):GOSUB5000:POKE A.AS:GOTO 2000
2300 POKE A.(AS+64):GOSUB5000:POKE A.AS:GOTO 2000
2500 POKE C.(BS+128):GOSUB5000:POKE C.BS:GOTO 2000
2700 POKE C.(BS+64):GOSUB5000:POKE C.BS:GOTO 2000
5000 FOR X=1TO 25:Y=SIN(X):NEXT X:RETURN:REM delay loop
6000 FOR X=1 TO 24:PRINT:NEXT X:RETURN:REM Clear screen
```

Table 6. This sample program was written for the Junior computer: with the aid of the information in this article it may be adapted for use with other computers.

Table 7.

20 DIM (P2) : T1 = 5 : A = 57088 : B = 57089 : C = 57090 : AS = 10 : BS = 10
or
20 DIM (P2) : T1 = 5 : A = 56832 : B = 56833 : C = 56834 : AS = 10 : BS = 10

Table 7. Adaptation of the program in table 6 for use with the C64: only line 20 needs to be changed.

```
10 REM programmable slide fader
20 POKE 16519.58
30 POKE 16520.132
40 POKE 16521.64
50 POKE 16522.211
60 POKE 16523.0
70 POKE 16524.201
80 POKE 16516.32
90 LET Y = USR 16519
100 POKE 16523.4
110 LET Y = USR 16519
120 POKE 16523.2
125 CLS
130 PRINT " 1) A on. B off "
140 PRINT " 2) A off. B on. "
150 PRINT " 3) A coming on. B fading "
160 PRINT " 4) A fading. B coming on "
170 PRINT " write in choice: "
180 INPUT K
190 IF K=1 THEN LET X=149
200 IF K=2 THEN LET X=169
210 IF K=3 THEN LET X=193
220 IF K=4 THEN LET X=131
230 POKE 16516.X
240 LET Y=USR 16519
250 GOTO 125
```

Table 8. A smaller sample program shows how the circuit may be controlled from a ZX81.

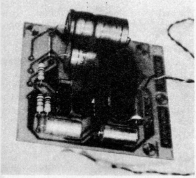
```
10 REM programmable slide fader
15 OUT 65342.32
16 OUT 65470.32
20 PRINT " 1) A on. B off "
30 PRINT " 2) A off. B on "
40 PRINT " 3) A coming on. B fading "
50 PRINT " 4) A fading. B coming on "
55 PRINT " 5) setting of fading speed "
56 PRINT " 6) Stop. "
60 INPUT " write in choice: "
90 IF K=1 THEN LET X=149
100 IF K=2 THEN LET X=169
110 IF K=3 THEN LET X=193
120 IF K=4 THEN LET X=131
125 IF K=5 THEN GOTO 150
126 IF K=6 THEN STOP
130 OUT 65406.X
135 CLS
140 GOTO 20
150 INPUT " write in fading speed of lamp A (1-63): ".SA
155 OUT 65342.SA
160 INPUT " write in fading speed of lamp B (1-63): ".SB
170 OUT 65470.SB
175 CLS
180 GOTO 20
```

Table 9. Another sample program to show how the circuit may be controlled from a ZX Spectrum.

gram for the ZX81 and ZX Spectrum respectively, and have been added to make clear the difference in the programming of these computers in comparison with table 6. Like that in table 6, these two programs are also menu controlled, a small menu in the case of the ZX81 and two small ones for the ZX Spectrum. Lines 20...80 in the ZX81 enable the "poking" of a machine language routine into the memory in the range of the REM line (line 10 which is therefore changed after the first program run). Lines 20...40 load accumulator A of the processor with the content of address decimal 16 516. Lines 50...60 arrange for this content to be carried onto the data bus, and lines 70...80 contain the RETURN command. Note that the user function is explained in chapter 26 of the BASIC handbook of the ZX81, and the OUT command in chapter 23 of the BASIC manual of the Spectrum.

Final remarks

Before taking the circuit into use, set presets P1 and P2 to the centre of their travel. Testing of the circuit should initially be carried with resistive loads only, even if you later want to control motors, that is, inductive loads.
The fading speed is set with P1 and this is a matter of personal taste.
Preset P2 should be set with the aid of a frequency counter or oscilloscope so that oscillator N9 operates at 25.6 kHz (50 Hz mains only: for other values, the oscillator frequency should be calculated from
$f_o = (512 f_m)^{-1}$ Hz,
where f_o is the oscillator frequency and f_m the mains frequency. The preset may also be adjusted 'visually' so that a fading lamp is only really 'out' when the fading process is at an end. When the circuit is subsequently used for the control of motors, it may be necessary to readjust P2 slightly. If it is impossible to adjust P2 for the stated frequencies, this is probably due to differences in trigger threshold between various makes of IC: the remedy is to increase or reduce, by trial and error, the value of C6.
With the information given in this article, it should be possible to use the circuit with current computers other than the ones mentioned here by carefully studying their documentation. You need four free addresses and the pin-out of the extension connector; programming may be carried out with the aid of the programming hints given in this article. ◼



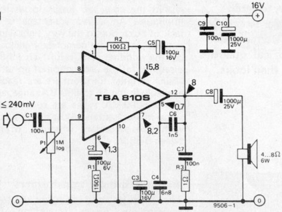
7 watt IC audio amplifier

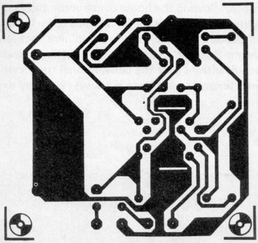
The TBA 810 has been in production for several years, and by now the price has dropped to a very reasonable level. It has built in thermal and short-circuit protection circuits, so it should have a reasonable life expectancy.
Without any additional cooling, the IC can deliver 1 Watt into a 4 Ω load with a 6 V supply. With a sufficiently large cooling fin and a 16 V supply it can deliver up to 7 W into 4 Ω; the input sensitivity in this case is 240 mV. If 8 Ω loudspeakers are used, the maximum output power is about half.

The input impedance is practically determined by P1 (1 M), so it is possible to connect a crystal cartridge direct to the input. If this high input impedance is not required, the value of P1 can be reduced.
There are two versions of the TBA810: the 'S' and the 'AS', with differently shaped cooling fins. The additional fin shown in the drawing is suitable for the 'S' version, but it will need some slight modifications to fit the 'AS' type.

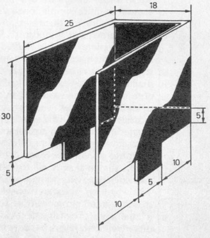
The frequency response is ±3 dB from 40 Hz to 18 kHz. The voltages shown in the circuit were measured when the unit was powered with a 16 V power supply. Note that the pin numbers in the circuit do not take account of the cooling fin; the IC has a total of 12 pins.

1

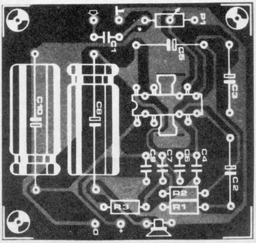




2



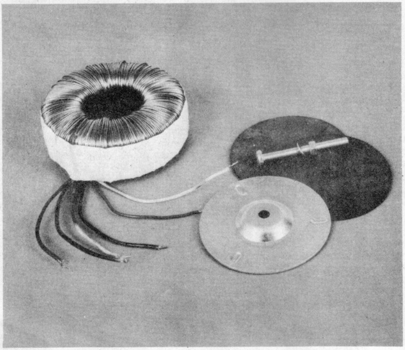
all dimensions in mm.



toroidal transformer

the best transformers . . . around!

Ring core or toroidal transformers are becoming fashionable. Thin is beautiful? As their name implies, they are 'round' and low in profile, allowing the home constructor and manufacturer, to build highly compact circuits. This seems to be necessary in order to satiate the public's appetite for any equipment that looks like a permanent 'Weight-Watcher'. Seriously, they do have excellent 'electrical' qualities, and advantages over the conventional transformer, other than looks. Unfortunately good taste is always relatively expensive.



The toroidal transformer has a ring core formed by a tightly bound metal laminated band. Copper windings are simply placed on the core without the use of bobbins.

The wire is wound over the complete surface of the core and this considerably aids the dissipation of heat. Due to the round shape, there is good 'concentration' of the magnetic flux lines in the core, thereby reducing the 'stray' fields.

It requires less wire than the conventional transformer for the equivalent number of windings, thus reducing the ohmic resistance, and the chance of overheating. So far so good. But why is the ring core transformer in most cases more expensive to buy than the conventional type? After all, they use less copper wire, no bobbins etcetera! Good question. The answer is that they take a lot longer to manufacture than conventional transformers, and today more than ever, time is money.

The core is formed as a complete ring without an air gap. It is made from a strip of high grade sheet steel, which is rolled up very tightly. The end of the strip is then welded, to prevent it unwinding. This form of construction helps to concentrate the lines of flux within the core and keeps losses to a minimum. An added advantage is its lack of buzz; due to the very tight 'laminations', which are completely enclosed by the winding. The result: an inbuilt disability for the production of noise.

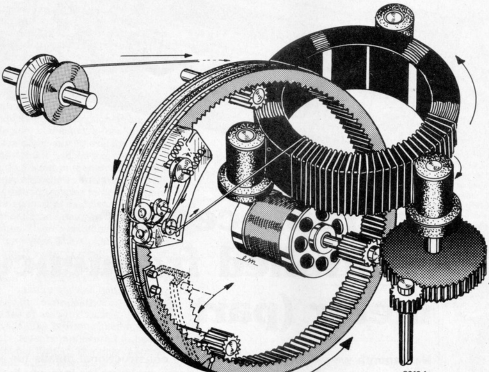
Mains toroidal transformers are readily available in the 15 to 680 VA range, and up to 5000 VA types are supplied by some manufacturers. Most are available with two secondary windings, of between 6-60 V.

Winding toroidal transformers

The manufacture of toroidal transformers may present something of a question mark to the inquisitive reader. As in most things of this nature, the answer is quite simple; once you know how! Figure 1 illustrates, what, in simple terms, actually occurs.

The complete core is loaded onto a machine that is able to hold and, rotate it. A ring, that is about three times the diameter of the core, is linked onto the core in much the same way as two links of a chain. This ring is called, not unreasonably, a shuttle and can also be rotated. While doing so, an amount of wire equalling one complete winding is fed onto it. And now we come to the 'trick' that makes it all so simple. The end of the wire is turned through 180° around a guide wheel on the shuttle, and held onto the outer edge of the core. The shuttle then reverses direction and lays the wire onto the core as one winding. The core is of course rotated slowly as this happens, so that the winding is evenly spread around it. Tension of the wire is easily

1



controlled. Mechanically this method is both simple and quick, and in fact takes just three minutes per winding.

The Lord of the Rings (Transformers)

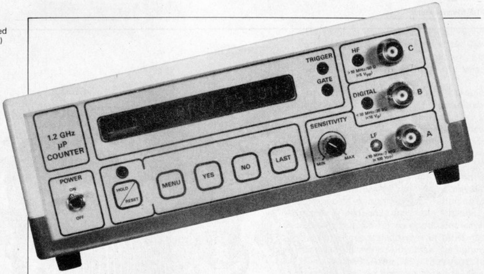
The equivalent conventional transformer is in most cases 2 to 3 times heavier. The same ratio in size also holds true.
The ring core transformer's 'iron losses', (when compared with the 'standard' conventional type), are only 10%. The advantage of the ring type are clearly noticeable when comparing 'stray fields'.
In a no-load situation the conventional field is at a maximum and the ring core at a minimum. With an increasing load the 'stray field' of the conventional decreases and the ring core's field increases in strength.
No matter what the situation, the stray field of the ring core type is always considerably smaller. Therefore using a toroidal transformer reduces the risk of unwanted noise being generated in any power supply circuit.

Quality costs money?

Toroidal transformers up to power ratings of 200 VA are more expensive to buy than conventional types. Above 200 VA and up to 500 VA this situation is reversed. A reasonably priced, compact, transformer above 200 VA is certainly useful, especially when building high power amplifiers.

Final remarks

Compared to the ordinary standard transformer, the high-grade core material of the toroidal type will cause a higher initial surge current; A slow-blow fuse on the primary winding is therefore necessary. A fuse having approximately double the value normally used with an equivalent conventional transformer should do the trick.
Even so, do not be alarmed if the whole neighbourhood is 'blacked out' the moment you switch on your new 2 x 50000 . . . W amplifier (with multiple toroidal transformers). This is a normal occurance!



microprocessor-controlled frequency meter (part 0)

Next month we will be publishing all the constructional details for a frequency meter. This is no ordinary meter, however, as it is small, very simple to use and at the same time quite easy to build yourself. All that is made possible by the microprocessor that controls the circuit. What exactly the microprocessor does you can find out in four weeks' time but just to whet your appetite have a look at the features listed here.

an introduction to an exceptional project featured next month.

Features

- microprocessor-controlled
- auto-ranging
- alphanumeric display (16 digit)
- simple to use with menu buttons
- frequency range: 0.01 Hz. . .1.2 GHz
- period time measurement: 10 ns. . .100 s
- pulse time measurement: 0.1 µs. . .100 s
- pulse counter up to 1×10^9
- high degree of accuracy even given the short time needed for frequency measurements
- 6 or 7 digit accuracy may be selected

The circuit for the new Elektor frequency meter is very unusual and because of this it deserves special attention. Totally unlike any other d.i.y. frequency meter, it is, of course, part of our range of test instruments.
We will look at it in functional sections, starting with the most unusual part of the circuit: the frequency measuring section. 'Normal' frequency meters make use of a crystal-controlled time base supplying an exact measuring time of 1 second, for example. During this 'gate time' the number of incoming cycles of the signal that is being measured are counted (see figure 1a). An accurate measurement is taken by using a measuring time long enough to enable a large number of cycles to be counted. Low frequency signals require a long measuring time but at high frequencies the time can be shorter. In 1 second only 10 cycles of a 10 Hz signal can be counted, for instance, so the read-out can only indicate a value of 10 plus or minus 1 Hz. If any figures are shown after the decimal point they are totally useless. In this case a measuring time of 10 s or longer is needed to give a reasonable degree of accuracy.
The new Elektor frequency meter uses a principle that is also used in modern professional instruments (see figure 1b). Once again a time base (providing a 10 MHz signal) and a counter are used. The signal to be measured goes first to a programmable divider. A microprocessor sets the division factor such that the counter is 'filled' as much as possible with pulses from the time base. This is exactly the opposite to the previous situation as in this case the gate time is supplied by the signal that is measured. The frequency of this signal is calculated by the microprocessor based on the division factor and the contents of the counter. The great

advantage of this method is that the instrument is always working at full accuracy and the measuring time is virtually constant, irrespective of the frequency measured. The microprocessor makes the calculations so fast that the user does not even have time to think about it.
An extra divider stage may be included to raise the upper limit of the frequency range from the standard 100 MHz to 1.2 GHz. The meter has three different inputs: one for analogue signals up to 10 MHz (with pre-settable sensitivity), one for digital signals up to 10 MHz and a high frequency input for signals above 10 MHz. The user can select a resolution of six or seven digits, giving average measuring times of 0.15 and 1.5 s respectively.
Using a microprocessor in this frequency meter also allows a number of other interesting features to be incorporated. The method of calculation chosen means that automatic range changing is a simple matter. 'User friendliness' is also a feature of the meter. The alphanumeric display shows the user in plain language what options are available and selection is a matter of pressing the 'yes' or the 'no' button. Pressing another button calls up the menu (the instrument then shows what its modes of use are), there is a 'last' button to recall the previous choice and the 'hold/reset button is used to freeze or reset the display. The only 'normal' switch in this whole instrument is that for the main power. The various different possible modes that can be chosen are shown in figure 2, which surely requires no further comment.
We could carry on listing all the wonderful features of this new frequency meter but that is not really necessary. One thing we will say, however, is that in spite of having some very expensive test equipment in our labs at Elektor this microprocessor-controlled frequency meter is probably the fastest and easiest to use. This is because hidden inside a mini case is a giant instrument. Can you afford to miss an offer like that?

1a

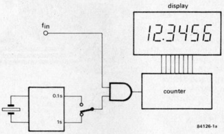


Figure 1a. This is the principle of operation generally used in frequency meters. During a crystal-controlled measuring time the cycles of the input signal are counted.

1b

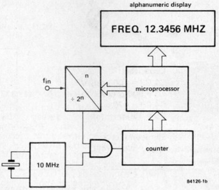


Figure 1b. The measuring time in the new Elektor frequency meter is provided by the input signal and the pulses provided by the time base are counted. A microprocessor calculates the frequency from the divider setting and the counter's contents.

2

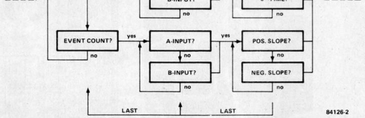
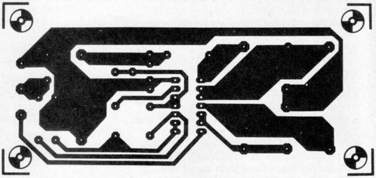
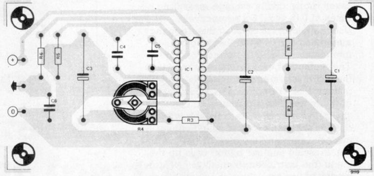


Figure 2. This is the frequency meter's menu. Any of these options can be selected using just two buttons. What could be simpler?

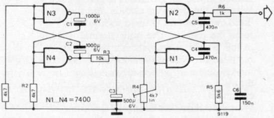
7400 siren





M. Mergel

The electronic siren described here is easy and cheap to build.
The circuit consists of two astable multivibrators, N1/N2 and N3/N4. The 0.2 Hz square-wave signal from the latter oscillator is integrated by R3 and C3; this voltage swings the frequency of the other AMV (N1/N2) up and down at 0.2 Hz.
The output level is about 2 $V_{p\text{-}p}$, sufficient to drive a power amplifier directly.



Parts list

Resistors:
R1,R2 = 4k7
R3 = 10 k
R4 = preset potentiometer 4k7
R5 = 5k6
R6 = 1 k

Capacitors:
C1,C2 = 1000 µ/6 V
C3 = 500 µ/6 V
C4,C5 = 470 n
C6 = 150 n

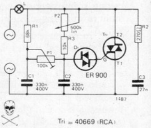
Semiconductor:
N1 . . . N4 = 7400

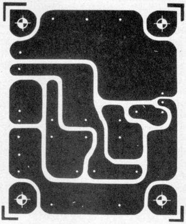
light dimmer

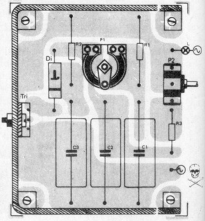
This simple triac dimmer can be used to control incandescent filament lamps up to 1500 W. The circuit operates on the phase-control principle. The main control is provided by P2. This determines the rate at which C2 charges and hence the point along the mains waveform at which the voltage on C2 reaches the breakdown voltage of the diac, which is when the triac is triggered. P1, in conjunction with R1 and C1 determines the minimum brightness level, or alternatively may be used as a fine brightness control. Interference suppression is provided by R2 and C3.

Construction

The printed circuit board is very compact and can easily be accommodated inside the modern, square type of flush-mounting switch panel, or in a small box for portable applications. The following safety points should be noted. No part of the circuit should be accessible from the outside. The case should preferably be made of plastic or other insulating material, and fixing screws for the board should be nylon. If a metal case is used the board must be adequately insulated from it and the case should be earthed. The potentiometer should have a plastic spindle.

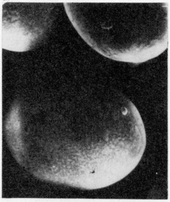






SOLDER PASTES

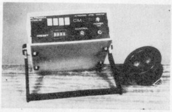
Electro Science Laboratories Inc. U.S.A have announced the availability of large particle pastes. These pastes make reflow soldering more reliable by inhibiting solder balls. As the solder paste flux melts before the alloy melts, very fine solder particles flow with it. away from the main mass of alloy, and become isolated. Fine particle powders also have more surface area for oxidation that can form a barrier to the main solder mass. ESL's large particle solder pastes inhibit these causes of solder balls.



For further information, write to:
Eltecks Corporation
C-314, Industrial Estate
Peenya, Bangalore 560 058.

ULTRASONIC LEVEL INDICATORS

ELTRONICA have developed non-contact type ultrasonic level indicator/controller-Model VUL-8 which can sense level by ultrasonic waves. The material can be liquid , powder or in form of lumps. The level is measured instantaneously and hence even dynamic level indication and control is possible. Measurement is fairly independent of temperature upto 70°C. The digital display is directly calibrated in mm or cm and BCD outputs are provided for control or printout.



For further information, write to:
Eltronica
98, Kaliyammankoil Street,
Verugambakkam, Madras 600 092.

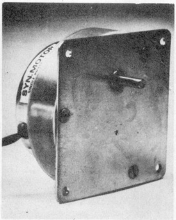
POCKET TRANSISTOR

Mini—Max one band pocket transistor radio set has been introduced by SAFARI Industries. The set is compact in construction and works on 3 volts using two pencil cells. It has an LED indicator for audio level indication.

For further information, write to :
Safari Industries
11, Tribhuvan Road,
Bombay 400 004.

GEARED SYNCHRONOUS MOTORS

VISHAL Electromag Industries have developed geared synchronous motors which are sturdy and compact. These motors can operate on 110V or 220/240V AC at 50Hz and consume 2.5 or 5 watts depending on the model. Out put speeds are available from 1 Sec./Rev. to 24Hrs./Rev. These motors are basically unidirectional and can be used directly for recorders, time-totalisers time switches, timers, maximum demand meters, action displays, oscillating grills in air conditioners and fans etc. The motors can also be made available as reversibel synchronous motors for potentiometers or servo voltage stabilisers.



For further information, write to :
Vishal Electromag Industries
D-202, Bonanza Industrial Estate, 2nd floor Ashok Chakarvarti Road,
Kandivli (East), Bombay 400 101.

SINGLE PHASING PREVENTER

ALTEK SYSTEMS introduce the Reliance PLG—single phasing preventer cum water level guard unit. This unit is used for protecting the motors of submersible pumps from single phasing and dry running. The single phasing preventer operates by sensing the negative sequence voltage and the water level guard operates by sensing the conductivity. The unit is available with housing or in open form to suit the requirement of control panel manufacturers.

For further information, write to :
Altek Systems
Plot 168, Sector 27,
P.C.N.T. Nigdi, Pune 411 044.

TEMPERATURE CONTROLLER

ESD—90/ESD-92 is the digital temperature indicator/controller introduced by Electronics Systems and Devices. A wide selection of measurement ranges is available to suit Thermocouple as well as RTDs. Large bright LEDs are used in the digital display of temperature being monitored. Ambient temperature compensation and thermocouple break protection are incorporated in the circuit. Input linearisation is also provided. The measurement is claimed to be unaffected by mechanical vibrations or mounting position of the instrument.

For further information, write to :
Electronics Systems and Devices
38-39/7, Hadapsar Industrial Estate,
Pune 411 013.

market

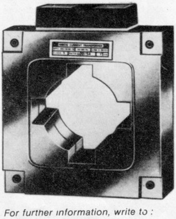
T/C SCANNER

The WAHL Data Force dual microprocessor controlled 40-channel temperature scanner computes, automatically measures and linearises upto 40 thermocouples every 2.5 seconds. The input channels accept any standard thermocouple types and are linearised to 0.005°C. The unit has 4 multiplex cards, each having 10 T/C input channels, with interchannel isolation of 300 V DC. Temperature readings are displayed with the 0.01°C resolution and the accuracy is + 0.2°C. Calculator functions such as weighted average, delta T, computed max/min, deviation, polynomial linearisation, cross channel computation etc. are also available.

For further information, write to:
Jost's Engineering Co. Ltd.
60. Sir Phirozeshah Mehta Road,
Bombay 400 001.

CURRENT TRANSFORMER

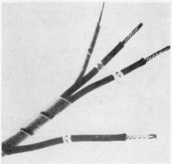
MECO Instruments Pvt. Ltd. have added a DIN type plastic moulded current transformer in four different models. The material of the moulded case is ABS and a cap is supplied for sealing the secondary terminals and to make the CT tamperproof. These can be mounted either on base plates or directly on bus-bars and are claimed to be unaffected by highly corrosive and dusty atmosphere.



For further information, write to :
Meco Instruments Pvt. Ltd.
Bharat Industrial Estate
T.J. Road, Sewree, Bombay 400 015

CABLE BINDING

NOVOFLEX offers Spirap cable binding system which permits flexible routing of Cable Harnesses while forming a neat, protective bundle. It twists on easily and quickly and allows lead-outs at any point. When Spirap is installed, it may be gapped for greater economy and flexibility or it may be butted tightly for maximum abrasion resistance, insulation protection and greater rigidity.



For further information, write to :
Novoflex Cable Care Systems
Post Box No. 9159 Calcutta 700 016.

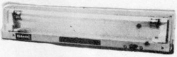
MINI TOGGLE SWITCH

Switchcraft now offer a miniature D.P.D.T. toggle switch rated for 250V AC at 2A. This switch is suitable for use as ON-OFF switch for electrical and electronic instruments. It is housed in a deep drawn brass casing which protects the inside mechanism from dust and moisture. The switch has a transfer moulded base with terminals moulded in it. The contacts are silver plated. Dimensions behind the panel are 13 (L) × 12 (W) × 18.5 (H) mm.

For further information, write to:
Switchcraft
54/55 Crescent Mansion
Gamdevi Road Bombay 400 007.

TUBE LIGHT INVERTER

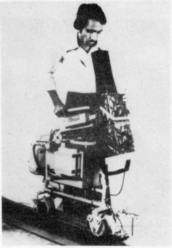
SBAJ tube light inverters are specially designed for the Bus body builders. They are completely solid state in design and use ferrite core transformers. 40% more efficient is claimed over the old lamination type transformer designs. The inverters are compact in size and can be fitted directly on the tube light fixture in place of the choke.



For further information, write to:
Sbaj Electronics
19, Mother Gift Building
Opp. Novelty Cinema
Grant Road, Bombay 400 007.

RAIL TESTER

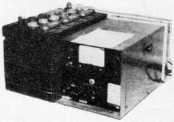
Vibronics Pvt. Ltd. have developed the ultrasonic rail tester equipment to meet the exacting standards set by RDSO. The equipment comprises of a portable flaw detector—model FD-301 A, with 5 sets of probes controlled through a junction box. The position of the probes can be raised or lowered as required. The applications consist of fatigue testing on rail head, testing of cracks on core bolt holes, cracks on web etc.



For further information, write to:
Vibronics Pvt. Ltd.
Masrani Estate
Near Halav Bridge
Kurla, Bombay 400 070.

UPS SYSTEM

JAYANT Electric & Radio Corpn. have introduced an uninteruptible power supply system to overcome the problems of transients, brownouts and blackouts. Various models are available ranging from 200 VA to 5 KVA. The system is mounted on a trolly with a battery and incorporates automatic electronic switching, dual function voltage stabiliser, battery charger with automatic trickle and boost charging etc. Output is 230 V ± 5% AC, single phase sine or square wave. Input can be 12 V to 110 V DC depending on the required capacity. Frequency of operation is 50 Hz ± 1%.



For further information write to:
Jayant Electric & Radio Corporation
5 B, Naigaum X-Road
P.B. 7129
Wadala, Bombay 400 031.

IOR

RUTTONSHA-INTERNATIONAL RECTIFIER PRIVATE LIMITED

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Graduates in Electrical/Electronics Engineering with a minimum of 10 to 12 years' experience in the sale of Power Electronics and Rectifier equipment and Semiconductor Devices. A thorough comprehension of the requirements of various industries using such equipment is essential. Prospective candidate must be result-oriented with proven record of achieving sales targets and capability to explore new markets as well as open up new areas of business. Major responsibility includes negotiations with top level officers and executives in Public and Private Undertakings. Selected candidates will be stationed at Bombay or Baroda but will have to travel extensively all over India.

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Graduates/Diploma Holders in Electrical/Electronics Engineering with a flair for sales and 4 to 6 years' experience in sales of Power Electronic equipment and Semi-conductor Devices. Candidates must have the capacity to effectively discuss with prospective clients techno-commercial aspects. Proven record of achieving order booking targets essential. Selected candidates may be posted at Bombay or Baroda.

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Graduates in Electrical/Electronics Engineering with 6 to 8 years' experience in Design & Development/ Production of Power Electronics and Rectifier equipment for Traction, Hydrogenation and other multifarious industrial applications and Semiconductor Devices. Thorough knowledge of circuitry is essential. Selected candidates will be posted at the Plants in Gujarat.

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Graduates in Electronics Engineering with 10 to 12 years' experience in the production of Power Electronic and Rectifier equipment for Traction, Hydrogenation and other multifarious industrial applications and Semiconductor Devices. Candidate must have a thorough knowledge of circuitry, production methods, engineering practices, labour relations and other responsibilities associated with the running of an independent manufacturing unit. Ability to lead a motivated group of qualified engineers and workmen, with a view to achieving production targets, are considered very essential. Working knowledge of Gujarati is necessary.

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THE MANAGING DIRECTOR
RUTTONSHA-INTERNATIONAL RECTIFIER PRIVATE LIMITED
Corporate Office :
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